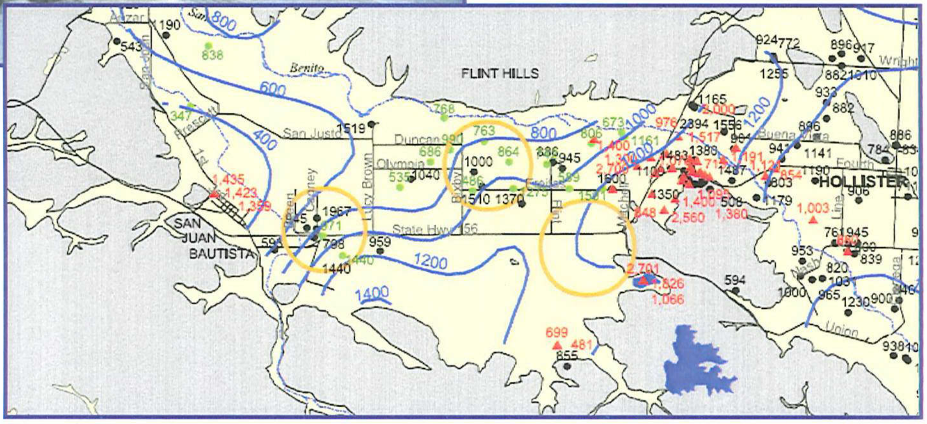
Pajaro River Watershed Groundwater Desalination Feasibility Study – Volume II: Appendices

San Benito County Water District
Santa Clara Valley Water District
Department of Water Resources Agreement #4600004126

Santa Clara Valley
Water District



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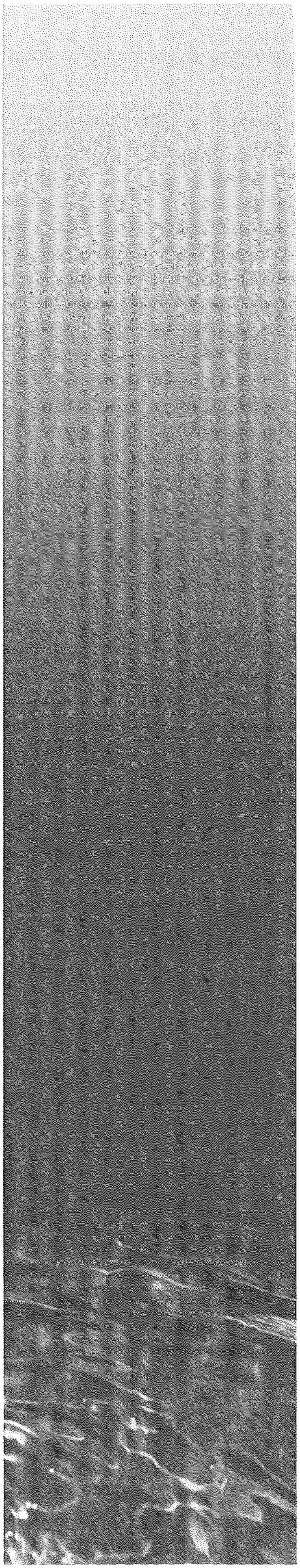

Appendix A

Drinking Water Source Assessment and Protection Program Documents

SANTA CLARA VALLEY WATER DISTRICT
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5750 ALMADEN EXPRESSWAY
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Pajaro River Watershed Groundwater Desalination Feasibility Study

APPENDICES TO BE USED FOR A GROUND WATER SOURCE

Appendix H

Drinking Water Source Location – Ground Water

Public water system: ________________________________ ID No.:_________________________

Name of source:____________________________________ ID No.:_________________________

Location date:____________ Source located by (name of person):_________________________

Method of determining location:

______USGS quad map (7.5 minute series, 1:24,000 scale), hand calculated

______USGS quad map (7.5 minute series, 1:24,000 scale), computer calculated

______Global Positioning System (GPS)

Unit (manufacturer/model): ________________________________

Accuracy of GPS unit (+/- _________ft.)

______Other Method ________________________________

Accuracy of method (+/- __________ft.)

Location of well (decimal degrees): Latitude:_____________________________________

Longitude:___________________________________

Physical description of location [Pertinent landmarks, address, or approximate address (cross streets, etc.)]:

General description of recharge area, if known:

NOTE: Indicate location of the well on the drinking water source assessment map. The map should also indicate locations of the source area and protection zones. (See other Appendices).

Appendix I

Delineation of Ground Water Protection Zones

Public water system: ______________________________ ID No.: ________________________

Name of source: __________________________________ ID No.: ________________________

Delineation date: ______________ Delineation conducted by ______________________________

Indicate the method used to delineate the zones:

______Calculated Fixed Radius (Default) (Show calculations below)

______Modified Calculated Fixed Radius (Show calculations below and attach documentation for direction of ground water flow)

______More detailed methods
Type used (i.e., analytical methods, hydrogeologic mapping, modeling):

______Arbitrary Fixed Radius (For use only by or with permission of DHS—use minimum distances shown below)

Calculated Fixed Radius Equation

The equation for the calculated fixed radius (R) is $R_t = \sqrt{Q\,t / \pi\,\eta\,H}$

$R_t = R_2$, R_5, or R_{10} corresponding to t (Calculate R for each of three times of travel, TOT)
Q = maximum pumping capacity of well
(ft^3/year = gpm x 70,267): _______________
t = time of travel (years), 2, 5 and 10 years
$\pi = 3.1416$
η = effective porosity (decimal percent) (If unknown, assume 0.2):
____
H = screened interval of well (feet) (If unknown, assume 10% of Q gpm, 10 ft minimum):
____

Specific methods follow on next page

Calculated Fixed Radius Delineation Method (Default)

Using the equation presented above, calculate the size of zones for the appropriate aquifer setting of the source.

Porous Media Aquifer

Zone A (2 year TOT) R_2 = ________ft, minimum = 600 ft —use larger: ______ft
Zone B5 (5 year TOT) R_5 = _________ft, minimum = 1,000 ft—use larger: ______ft
Zone B10 (10 year TOT) R_{10} = ________ft, minimum = 1,500 ft—use larger: ______ft

Fractured Rock Aquifer

(Increase size of zones by 50%)

Zone A (2 year TOT) $1.5R_2$ = ________ft, minimum = 900 ft—use larger: ______ft
Zone B5 (5 year TOT) $1.5R_5$ = ______ft, minimum = 1,500 ft—use larger: ______ft
Zone B10 (10 year TOT) $1.5R_{10}$ = ______ft, minimum = 2,250 ft—use larger: ______ft

Modified Calculated Fixed Radius Delineation Method

In porous media aquifers, if the direction of ground water flow is known (see Section 6.2.3), the default zone circle may be shifted upgradient by $0.5R_t$. The upgradient and downgradient limits of the zone are determined below.

Zone A (2-year TOT)

upgradient distance = $1.5R_2$ = _________ft, minimum = 900 ft, use larger: _________ft
downgradient distance = $0.5R_2$ = _________ft, minimum = 300 ft, use larger: _________ft

Zone B5 (5-year TOT)

upgradient distance = $1.5R_5$ = _______ft, minimum = 1,500 ft, use larger: _________ft
downgradient distance = $0.5R_5$ = _______ft, minimum = 500 ft, use larger: __________ft

Zone B10 (10-year TOT)

upgradient distance = $1.5R_{10}$ = ________ft, minimum = 2,250 ft, use larger: ________ft
downgradient distance = $0.5R_{10}$ = _________ft, minimum = 750 ft, use larger: ________ft

Appendix J

Physical Barrier Effectiveness Checklist and Well Data Sheet - Ground Water Source

Public water system: ______________________________ ID No.:______________________

Name of source:___________________________________ ID No.:______________________

Assessment date:______________ Assessment conducted by ____________________________

Complete DHS Well Data Sheet (attached) and include with Assessment submittal.

Directions:

1. Read through the form and collect the information needed to complete the form. (Hydrogeology, Soils, Presence of abandoned or improperly destroyed wells, Well construction and operation.)

2. Determine Parameter A, Type of Aquifer.
   - If the aquifer is confined, use the right-hand column, and evaluate only the parameters indicated for confined aquifers.
   - If the aquifer is unconfined, semi-confined, or the degree of confinement is unknown, or if the aquifer is fractured rock, use the left-hand column and evaluate only the parameters for unconfined aquifers.

3. For each parameter appropriate for the source, place a check in the box for the answer that most closely applies to that source. If more than one answer is possible, select the more conservative (i.e., lower points) answer. *[For example, if the depth to static water (Parameter D) has varied between 45 and 55 feet, choose answer 2 (20 to 50 feet).]*

4. Add the points in the column appropriate for the source and interpret the score as shown on the bottom of the last page.
   - Determine whether the source has a High, Moderate or Low Physical Barrier Effectiveness. Use this in the Vulnerability analysis. The higher the points, generally the more effective the source and site are to retarding the movement of contaminants to the water supply.

NOTE: If the source is located in fractured rock the source is considered to have a Low Physical Barrier Effectiveness, regardless of the point total. So, if Parameter B, Aquifer Material is 3, the remainder of the form does not need to be completed.

Physical Barrier Effectiveness (PBE) – Ground Water, page 1 of 2

Source Name:__________________________________Source No.:____________________

PARAMETER	*POINTS*			
	Unconfined		Confined	
A. TYPE OF AQUIFER Confinement *(up to **50** points maximum)* choose one				
a. Unconfined, Semi-confined, Fractured Rock, Unknown	0			
b. Confined			50	
B. AQUIFER MATERIAL (Unconfined Aquifer) Type of materials within the aquifer *(up to **20** points maximum)* choose one				
1. Porous Media (Interbedded sands, silts, clays, gravels) with continuous clay layer minimum 25' thick above water table within Zone A	20			
2. Porous Media (Interbedded sands, silts, clays, and gravels)	10			
3. Fractured rock * (* Low Physical Barrier Effectiveness - no further questions required)	0			
C. PATHWAYS OF CONTAMINATION (All Aquifers) Presence of Abandoned or Improperly Destroyed Wells *(up to **10** points maximum)*				
1. Are they present within Zone A (2-year time of travel (TOT) distance)?				
a. Yes or unknown	0		0	
b. No	5		5	
2. Are they present within Zone B5 (2- to 5-year TOT distance)?				
a. Yes or unknown	0		0	
b. No	3		3	
3. Are they present within Zone B10 (5- to 10-year TOT distance)?				
a. Yes or unknown	0		0	
b. No	2		2	
D. STATIC WATER CONDITIONS (Unconfined Aquifer) Depth to static Water (DTW) = ______ feet *(up to **10** points maximum)* choose one				
1. 0 to 20 feet	0			
2. 20 to 50 feet	2			
3. 50 to 100 feet	6			
4. > 100 feet	10			
E. WELL OPERATION (Unconfined Aquifer) Depth to Uppermost Perforations (DUP) DUP = ______ feet Maximum Pumping Rate of Well (Q) Q = ______ gallons/minute Length of screened interval (H) H = ______ feet				
[(DUP – DTW) / (Q/H)] = *(up to **10** points maximum)* choose one				
1. < 5	0			
2. 5 to 10	5			
3. > 10	10			

Physical Barrier Effectiveness – Ground Water, page 2 of 2

Source Name:________________________________Source No.____________________________

PARAMETER	*POINTS*			
	Unconfined		Confined	
F. HYDRAULIC HEAD (Confined Aquifer) What is the relationship in hydraulic head between the confined aquifer and the overlying unconfined aquifer? (i.e., does the well flow under artesian conditions?) *(up to **20** points maximum)* choose one				
1. head in confined aquifer is higher than head in unconfined aquifer under all conditions			20	
2. head in confined aquifer is higher than head in unconfined aquifer under static conditions			10	
3. head in confined aquifer is lower than or same as head in unconfined aquifer			0	
4. unknown			0	
G. WELL CONSTRUCTION (All Aquifers) 1. Sanitary Seal (Annular Seal) Depth = ______ feet *(up to **10** points maximum)* choose one				
a. None or less than 20 feet deep	0		0	
b. 20 to 50 ft deep	6		10	
c. 50 ft or greater	10		10	
2. Surface seal (concrete cap) *(up to 4 points maximum)* choose one				
a. Not present or improperly constructed	0		0	
b. Watertight, slopes away from well, at least 2' laterally in all directions	4		4	
3. Flooding potential at well site *(up to **1** point maximum)* choose one				
a. Subject to localized flooding (i.e. in low area or unsealed pit or vault) or Within 100 year flood plain	0		0	
b. Not subject to flooding	1		1	
4. Security at well site *(up to **5** points maximum)* choose one				
a. Not secure	0		0	
b. Secure (i.e. housing, fencing, etc.)	5		5	
Maximum Points Possible	70		100	
POINT TOTAL FOR THIS SOURCE				

Physical Barrier Effectiveness SCORE INTERPRETATION

Point Total		**Effectiveness**	
______**0 to 35**	=	**Low**	(includes all sources in Fractured Rock)
______**36 to 69**	=	**Moderate**	
______**70 to 100**	=	**High**	

WELL DATA SHEET (Sheet 1 of 3)

Complete as much information as possible. Leave blank if information is not available, use N.A. if not applicable.		
** Indicates items required for Source Water Assessment*	*** Indicates additional items required for Ground Water Rule*	
		Actual or Estimated?
DATA SHEET GENERAL INFORMATION		
System Name		
System Number		
Source of Information *(See Note 1)*		
Personnel Collecting Information		
Date		
WELL IDENTIFICATION		
* Well Number or Name		
* DHS Source Identification Number (FRDS ID No.)		
DWR Well Log on File? (yes or no)		
State Well Number (from DWR)		
Well Status (Active, Standby, Inactive)		
Date of Inactive Status (if applicable)		
WELL LOCATION		
Latitude		
Longitude		
Elevation		
Street Address		
* Neighborhood/Surrounding Area *(see Note 2)*		
Site plan on file? (yes or no)		
DWR Ground Water Basin		
DWR Ground Water Sub-basin		
SANITARY CONDITIONS		
** Distance to: Sewer Line, Sewage Disposal, or Septic tank		
Distance to: Other sanitary concerns		
Distance to: Other Wells (Active)		
Distance to: Other Wells (Abandoned)		
** Size of controlled area around well (square feet)		
* Type of access control to well site *(See Note 3)*		
* Surface Seal? (Concrete slab) (yes or no)		
* Dimensions of concrete surface slab (ft)		
* Within 100 year flood plain? (yes or no)		
* Drainage away from well? (yes or no)		
ENCLOSURE/HOUSING		
Type		
Condition		
Pit depth (if applicable)		
Pit Drained? (if applicable)		
Floor (material)		

WELL DATA SHEET (Sheet 2 of 3)

WELL CONSTRUCTION		Actual or Estimated?
Date drilled		
Drilling Method		
Depth of Bore Hole (feet below ground surface)		
Casing Depth (feet below ground surface)		
Casing Diameter (inches)		
Casing Material		
Additional casing depth (if applicable)		
Additional casing diameter (if applicable)		
Additional casing material (if applicable)		
Conductor casing used? (yes or no) *(See Note 4)*		
Conductor casing removed? (yes or no)		
* Depth to highest perforations/screens(ft below surface)		
Depth(s) and Length(s) of screened interval(s)		
* Total length of screened interval		
* Annular Seal? (yes, no, or not sure) *(See Note 5)*		
* Depth of Annular Seal (ft)		
Material of Annular Seal (cement grout, bentonite, etc.)		
Gravel pack, Depth to top (ft below ground surface)		
Total length of gravel pack (ft)		
AQUIFER		
* Aquifer Materials *(See Note 6)*		
* Confining layer (impervious strata) above aquifer? (yes, no or not sure)		
Thickness of confining layer, if known (ft)		
Depth to confining layer, if known (ft below ground)		
Sanitary Seal terminates in impervious strata? (yes or no)		
* Static water level (ft below ground surface)		
Pumping water level (ft below ground surface)		
Date water level measured		
WELL PRODUCTION		
Well Yield (gpm)		
Well Yield Based On (i.e., pump test, etc.)		
Date measured		
Production (gallons per year)		
Frequency of Use (hours/year)		
Typical pumping duration (hours/day)		
PUMP		
Make		
Type		
Size (hp)		
* Capacity (gpm)		
Depth to suction intake (ft below ground surface)		

WELL DATA SHEET (Sheet 3 of 3)

		Actual or Estimated?
Lubrication Type		
Type of Power: (i.e., electric, diesel, etc.)		
Auxiliary power available? (yes or no)		
Operation controlled by: *(See Note 7)*		
Pump to Waste capability? (yes or no)		
Discharges to: (i.e., distribution system, storage, etc.)		
(Use or note these items as appropriate)		
Raw Water Quality concerns? (coliform, chemicals, other)		
Continuous Chlorination provided?		
Pitless Adapter? Make and Model		
Height of pump base (inches)		
Casing Vent? (yes or no)		
Air/Vacuum Release? (yes or no)		
Sampling Taps? (yes or no)		
Location of sampling taps		
Wellhead Riser? (yes or no) height above well		

NOTES

1. Sources of information: well log, DHS or County files, system files, personnel, etc.

2. Neighborhood/Surrounding Area (list all that apply):
A= Agricultural, Ru = Rural, Re = Residential,
Co = Commercial, I = Industrial, Mu = Municipal,
P = Pristine, O = Other

3. Access Control: fencing, building, etc.

4. Annular Seal - Seal of grout in the space between the well casing and the wall of the drilled hole. Sometimes called "sanitary seal".

5. Conductor Casing - Oversized casing used to stabilize bore hole during well construction. Usually removed during installation of annular seal.

6. Aquifer materials (list all that apply): sands, silts, clays, gravel, rocks, fractured rock

7. Operation controlled by: level in tank, system demand, pressure, etc.

Appendix K

Possible Contaminating Activity (PCA) Inventory Form

Ground Water Source

Public water system name:______________________________ID No.________________

Name of drinking water source:__________________________ID No.________________

Inventory date:____________________ Inventory conducted by:______________________

Indicate PCAs pertinent to the drinking water source, its source area and protection zones, from the following tables, as applicable:

Commercial/Industrial (Table K-1) ______

Residential/Municipal (Table K-2) ______

Agricultural/Rural (Table K-3) ______

Other (required for all) (Table K-4) ______

Is this for a ground water recharge area? YES/NO __________ (If YES, also use Appendix D, Tables D-1 through D-4, as appropriate)

Attach map of Drinking Water Source with Zones A, B5 and B10 indicated, and buffer zones (if defined).

Proceed to appropriate checklist or checklists. Place a mark in the appropriate boxes.
Example:

		X

Risk Ranking of PCAs (see Tables 7-2, 7-3, 7-4 and 7-5 for separate category lists), where VH = Very High Risk, H = High Risk, M = Moderate Risk, L = Low Risk

PCA Checklist
Table K-1, page 1 of 2

COMMERCIAL/INDUSTRIAL

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Automobile-related activities						
Body shops (H)						
Car washes (M)						
Gas stations (VH)						
Repair shops (H)						
Boat services/repair/ refinishing (H)						
Chemical/petroleum processing/storage (VH)						
Chemical/petroleum pipelines (H)						
Dry cleaners (VH)						
Electrical/electronic manufacturing (H)						
Fleet/truck/bus terminals (H)						
Furniture repair/ manufacturing (H)						
Home manufacturing (H)						
Junk/scrap/salvage yards (H)						
Machine shops (H)						
Metal plating/ finishing/fabricating (VH)						
Photo processing/printing (H)						
Plastics/synthetics producers (VH)						
Research laboratories (H)						

PCA Checklist
Table K-1, page 2 of 2

COMMERCIAL/INDUSTRIAL

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Wood preserving/treating (H)						
Wood/pulp/paper processing and mills (H)						
Lumber processing and manufacturing (H)						
Sewer collection systems (H, if in Zone A, otherwise L)						
Parking lots/malls (>50 spaces) (M)						
Cement/concrete plants (M)						
Food processing (M)						
Funeral services/graveyards (M)						
Hardware/lumber/parts stores (M)						
Appliance/Electronic Repair (L)						
Office buildings/complexes (L)						
Rental Yards (L)						
RV/mini storage (L)						
Other (list)						

PCA Checklist
Table K-2, page 1 of 2

RESIDENTIAL/MUNICIPAL

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Airports - Maintenance/ fueling areas (VH)						
Landfills/dumps (VH)						
Railroad yards/ maintenance/ fueling areas (H)						
Septic systems - high density (>1/acre) (VH if in Zone A, otherwise M)						
Sewer collection systems (H, if in Zone A, otherwise L)						
Utility stations - maintenance areas (H)						
Wastewater treatment and disposal facilities (VH in Zone A, otherwise H)						
Drinking water treatment plants (M)						
Golf courses (M)						
Housing - high density (>1 house/0.5 acres) (M)						
Motor pools (M)						
Parks (M)						
Waste transfer/recycling stations (M)						

PCA Checklist
Table K-2, page 2 of 2
RESIDENTIAL/MUNICIPAL

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Apartments and condominiums (L)						
Campgrounds/ Recreational areas (L)						
Fire stations (L)						
RV Parks (L)						
Schools (L)						
Hotels, Motels (L)						
Other (list)						

PCA Checklist
Table K-3, page 1of 2

AGRICULTURAL/RURAL

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Grazing (> 5 large animals or equivalent per acre) (H in Zone A, otherwise M)						
Concentrated Animal Feeding Operations (CAFOs) as defined in federal regulation[1] (VH in Zone A, otherwise H)						
Animal Feeding Operations as defined in federal regulation[2] (VH in Zone A, otherwise H)						
Other Animal operations (H in Zone A, otherwise M)						
Farm chemical distributor/ application service (H)						
Farm machinery repair (H)						
Septic systems – low density (<1/acre) (H in Zone A, otherwise L)						
Lagoons / liquid wastes (H)						
Machine shops (H)						
Pesticide/fertilizer/ petroleum storage & transfer areas (H)						
Agricultural Drainage (H in Zone A, otherwise M)						
Wells - Agricultural/ Irrigation (H)						

PCA Checklist
Table K-3, page 2 of 2

AGRICULTURAL/RURAL

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Managed Forests (M)						
Crops, irrigated (Berries, hops, mint, orchards, sod, greenhouses, vineyards, nurseries, vegetable) (M)						
Fertilizer, Pesticide/ Herbicide Application (M)						
Sewage sludge/biosolids application (M)						
Crops, nonirrigated (e.g., Christmas trees, grains, grass seeds, hay, pasture) (L) (includes drip-irrigated crops)						
Other (list)						

3. Concentrated Animal Feeding Operation: Animal Feeding Operation (requires NPDES permit) with greater than:

If pollutants discharged (directly or indirectly) to navigable waters	**If pollutants not discharged**
300 slaughter or feeder cattle	1,000 slaughter or feeder cattle
200 mature dairy cows	700 mature dairy cows
750 swine	2500 swine
150 horses	500 horses
3000 sheep or lambs	10,000 sheep or lambs
16,500 turkeys	55,000 turkeys
9,000 laying hens or broilers (liquid manure system)	30,000 laying hens or broilers (liquid manure system)
1500 ducks	5000 ducks
300 animal units	1000 animal units

4. Animal Feeding Operation: lot or facility where animals (other than aquatic) have been or will be stabled or confined and fed or maintained for total of 45 days or more in any 12 month period.

PCA Checklist
Table K-4, page 1 of 3
OTHER ACTIVITIES

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
NPDES/WDR permitted discharges (H)						
Underground Injection of Commercial/Industrial Discharges (VH)						
Historic gas stations (VH)						
Historic waste dumps/ landfills (VH)						
Illegal activities/ unauthorized dumping (H)						
Injection wells/ dry wells/ sumps (VH)						
Known Contaminant Plumes (VH)						
Military installations (VH)						
Mining operations - Historic (VH)						
Mining operations – Active (VH)						
Mining - Sand/Gravel (H)						
Wells – Oil, Gas, Geothermal (H)						
Salt Water Intrusion (H)						
Recreational area—surface water source (H)						

PCA Checklist
Table K-4 , page 2 of 3

OTHER ACTIVITIES

PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Underground storage tanks						
Confirmed leaking tanks (VH)						
Decommissioned - inactive tanks (L)						
Non-regulated tanks (tanks smaller than regulatory limit) (H)						
Not yet upgraded or registered tanks (H)						
Upgraded and/or registered - active tanks (L)						
Above ground storage tanks (M)						
Wells – Water supply (M)						
Construction/demolition staging areas (M)						
Contractor or government agency equipment storage yards (M)						
Dredging (M)						
Transportation corridors						
Freeways/state highways (M)						
Railroads (M)						
Historic railroad right-of-ways (M)						
Road Right-of-ways (herbicide use areas) (M)						
Roads/ Streets (L)						

PCA Checklist
Table K-4, page 3 of 3

OTHER ACTIVITIES						
PCA (Risk Ranking)	No PCA in zones	PCA in Zone A?	PCA in Zone B5?	PCA in Zone B10?	Unknown	Comments
Hospitals (M)						
Storm Drain Discharge Points (M)						
Storm Water Detention Facilities (M)						
Artificial Recharge Projects						
Injection wells (potable water) (L)						
Injection wells (non-potable water) (M)						
Spreading Basins (potable water) (L)						
Spreading Basins (non-potable water) (M)						
Medical/dental offices/clinics (L)						
Veterinary offices/clinics (L)						
Surface water - streams/ lakes/rivers (L)						
Wells – monitoring, test holes (L)						
Other (list)						

Appendix L

Possible Contaminating Activities Evaluation– Ground Water Source

(Note: This form is OPTIONAL. It should be completed for each PCA if a modification of the risk ranking of a PCA is desired)

Public water system ________________________________ ID No. ____________ ______

Name of source ________________________________ ID No. ______________

Assessment date:______________ Assessment conducted by ________________________

PCA/Potential Contaminant Information

1. Type of Activity (from the PCA contaminant inventory checklist):

2. Type of potential contaminant associated with this activity (Refer Table 7-2):
    a. Microbiological
    b. Chemical
    c. Both or Other

3. Potential Risk (from PCA contaminant inventory checklist):
    a. Low
    b. Medium
    c. High
    d. Very High

4. Location:
    a. Zone A
    b. Zone B5
    c. Zone B10

5. Spatial Area occupied by activity as percentage of Zone:
    a. Small (<1% of area)
    b. Moderate (1% to 10% of area)
    c. High (>10% of area)
    d. Unknown

6. Volume of potential contaminant *(not applicable for microbiological contaminants)*:
   If the maximum quantity of potential contaminant stored at the facility were discharged into

the quantity of water produced by the drinking water supply in a day would the concentration be:
   a. Small (less than one part per billion)
   b. Moderate (between one part per thousand and one part per billion)
   c. High (more than one part per thousand)
   d. Unknown

7. Magnitude of potential acute or chronic health effects associated with the contaminant:
   a. Low
   b. High
   c. Unknown

8. Likelihood of potential contaminant to migrate to drinking water supply:
   a. Low
   b. High
   c. Unknown

9. Has the potential contaminant been detected in the drinking water supply or near-by monitoring wells?
   a. Yes
   b. No
   c. Unknown

10. Compliance of facility (demonstrated performance to keep potential contaminant from being discharged)
   a. Good
   b. Poor
   c. Unknown

Determination of revised risk ranking for PCAs

Microbiological Contamination

NOTE: In fractured rock aquifers, microbiological PCAs are always high risk, regardless of the zone, and cannot be modified.

If the PCA is categorized as **2a or 2c**, the risk ranking would be LOW if the PCA meets all of the parameters in the table below for **Low.** The risk ranking would be HIGH if the PCA meets all of the parameters in the table for **High**. Otherwise the risk ranking is MODERATE.

Microbiological Contamination
PCA Risk Ranking

Parameter	Low	High
3	**a or b**	**c or d**
4	**b or c**	**a**
5	**a**	**c or d**
7	**a**	**b or c**
8	**a**	**b or c**
9	**b**	**a or c**
10	**a**	**b or c**

Chemical Contamination

If the PCA is categorized as **2b or 2c**, the risk ranking would be LOW if the PCA meets all of the parameters in the table below for **Low.** The risk ranking would be HIGH if the PCA meets all of the parameters in the table for **High**. Otherwise the risk ranking is MODERATE.

Chemical Contamination
PCA Risk Ranking

Parameter	Low	High
3	**a or b**	**c or d**
4	**c**	**a or b or c**
5	**a**	**c or d**
6	**a**	**c or d**
7	**a**	**b or c**
8	**a**	**b or c**
9	**b**	**a or c**
10	**a**	**b or c**

Appendix M

Vulnerability Analysis Procedures – Ground Water Source

The Vulnerability analysis incorporates the types of Possible Contaminating Activities (PCAs) identified in the inventory, their respective Risk Rankings, the Zone and the Physical Barrier Effectiveness determination. These factors are used to develop a prioritized listing of types of PCAs and to determine the types of PCAs to which the drinking water source is most vulnerable.

Public water system: ______________________________ ID No.: ______________________

Name of source: ___________________________________ ID No.: ______________________

Assessment date: ______________ Assessment conducted by ___________________________

Vulnerability analysis steps:

1. For each type of PCA identified as existing in the protection zones, or as unknown, determine the number of PCA risk ranking points for that type of PCA. (If the risk ranking for a type of PCA has been modified, Appendix L should be attached). (*For example, Very High (VH) risk activities are 7 points.)*

2. For each type of PCA determine the zone in which it occurs. Add the points associated with that zone to the PCA risk ranking points. If the type of PCA exists within more than one zone, repeat the process for each zone. (*For example, if a type of PCA exists in Zone A add 5 points. For a VH risk PCA in Zone A, the PCA Risk Ranking points + Zone points = 7 + 5 = 12 points.*)

3. Determine the Physical Barrier Effectiveness (PBE) for the drinking water source (from Appendix J). Add the points associated with that PBE to the PCA risk ranking and zone points. The total is the Vulnerability Score. (*For example, if the PBE is Low add 5 points. For a VH risk PCA in Zone A, the Vulnerability Score = PCA Risk Ranking points + Zone points + PBE points = 7 + 5 + 5 = 17 points.)*

4. Prioritize all types of PCAs by the Vulnerability Score, from the most points to the least. A sample form is shown below.

5. The drinking water source is vulnerable to all types of PCAs with a Vulnerability Score of **8** or greater. Refer to the Vulnerability Matrix below. The source is most vulnerable to the types of PCAs with the highest score.

6. **In addition, the Drinking Water Source is most vulnerable to all types of PCAs associated with a contaminant detected in the water source, regardless of Vulnerability Score.**

Vulnerability Matrix for GROUND WATER SOURCES

The cutoff point for vulnerability is **8**. The drinking water source is considered Vulnerable to all PCAs with Vulnerability Score greater than or equal to **8** (shaded boxes).

PCA points	**Zone points**	**PCA + Zone points**	**PBE Points**			**Vulnerability Score PCA + Zone + PBE points**		
Risk Ranking	A, B5, B10		Low	Mod	High	PBE Low	PBE Mod	PBE High
VH (7)	A (5)	12	5	3	1	17	15	13
VH (7)	B5 (3)	10	5	3	1	15	13	11
VH (7)	B10 (1)	8	5	3	1	13	11	9
VH (7)	Unknown (0) *	7	5	3	1	12	10	8
H (5)	A (5)	10	5	3	1	15	13	11
H (5)	B5 (3)	8	5	3	1	13	11	9
H (5)	B10 (1)	6	5	3	1	11	9	7
H (5)	Unknown (0) *	5	5	3	1	10	8	6
M (3)	A (5)	8	5	3	1	13	11	9
M (3)	B5 (3)	6	5	3	1	11	9	7
M (3)	B10 (1)	4	5	3	1	9	7	5
M (3)	Unknown (0) *	3	5	3	1	8	6	4
L (1)	A (5)	6	5	3	1	11	9	7
L (1)	B5 (3)	4	5	3	1	9	7	5
L (1)	B10 (1)	2	5	3	1	7	5	1
L (1)	Unknown (0) *	1	5	3	1	6	4	2

* Source is considered vulnerable to types of PCAs that are Unknown, if the Vulnerability Score is 8 or higher.

Format for Prioritized Listing of PCAs

List types of PCAs in order by Vulnerability Score from highest to lowest.

Zone	Type of PCA	PCA Points VH = 7 H = 5 M = 3 L = 1	Zone Points A = 5 B5 = 3 B10 = 1 Unknown = 0	PBE Points L = 5 M = 3 H = 1	Vulnerability Score PCA points + Zone points + PBE points

Appendix N
Checklist for Drinking Water Source Assessment – Ground Water Source

Public water system: ______________________________ ID No.:_________________________

Name of source:____________________________________ ID No.:_________________________

Assessment date:__________ Assessment conducted by_________________________________

The following information should be contained in the drinking water source assessment submittal.

If another report that is the functional equivalent to the drinking water assessment (e.g., parts of a Ground Water Management Plan) is included in this assessment, the part of that report that fulfills the components of the source water assessment should be clearly indicated.

_______Source name, system name, source and system identification numbers, date of assessment, name of person and/or organization conducting the assessment (Appendix N, this form)

_______Assessment map with source location, source area (if known), and protection zones

_______Drinking water source location coordinates and accuracy of method used (Appendix H or equivalent)

_______Delineation of protection zones (Appendix I or equivalent)

_______Drinking water Physical Barrier Effectiveness Checklist (Appendix J)

_______Well Data Sheet

_______Possible contaminating activity (PCA) inventory form (Appendix K)

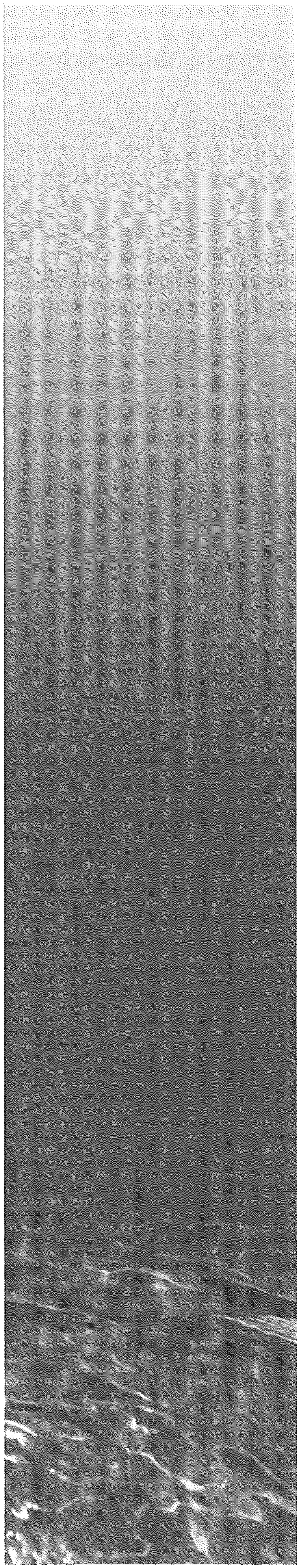
_______Possible contaminating activities evaluation (optional) (Appendix L)

_______Vulnerability ranking (Appendix M)

_______Additional maps (optional) (e.g., local maps of zones and PCAs, recharge area maps, or maps indicating direction of ground water flow)

_______Means of Public Availability of Report (indicate those that will be used)

  ______Notice in the annual consumer confidence report* (minimum)
  ______Copy in DHS district office (minimum)
  ______Copy in public water system office (recommended)
  ______Copy in public library/libraries
  ______Internet (indicate Internet address: _________________________)
  ______Other (describe)
  *The annual report should indicate where customers can review the assessments.



Appendix B

Groundwater Model Documentation

Pajaro River Watershed Groundwater Desalination Feasibility Study

Groundwater Model Documentation

The primary tool used to evaluate potential impacts on groundwater was a groundwater flow and solute transport model developed by San Benito County Water District and San Benito County. The model was first developed and documented in 2002 (Yates and Zhang 2001) but has evolved since then, including modifications implemented specifically to better evaluate impacts of the wastewater system improvements project. The model is regional in extent, covering the entire San Benito County portion of the Gilroy-Hollister groundwater basin. The groundwater flow component of the model uses the MODFLOW2000 computer program developed by the U. S. Geological Survey (Harbaugh and others, 2000). Groundwater salinity is simulated using the solute transport program MT3DMS (Zheng and Wang, 1999), which functions as an extension to MODFLOW2000. Numerous spreadsheets, geographic information system (GIS) maps and Fortran utility programs were also developed to prepare input data sets for the models and to extract and display selected simulation results.

The finite-difference model grid includes five layers to enable simulation of vertical differences in groundwater levels and salt concentration. Grid cells are 250 x 250 feet near the DWTP and IWTP and increase to 1000 x 1000 feet in the rest of the basin. **Figure A-1** shows the extent of the model and the finite-difference grid used in the model to simulate water levels at discrete points across the basin. The model has continued to evolve since 2001 as new information becomes available and to improve its capabilities. This includes modifications specifically implemented for the wastewater system improvements project. Modifications implemented since 2001 include:

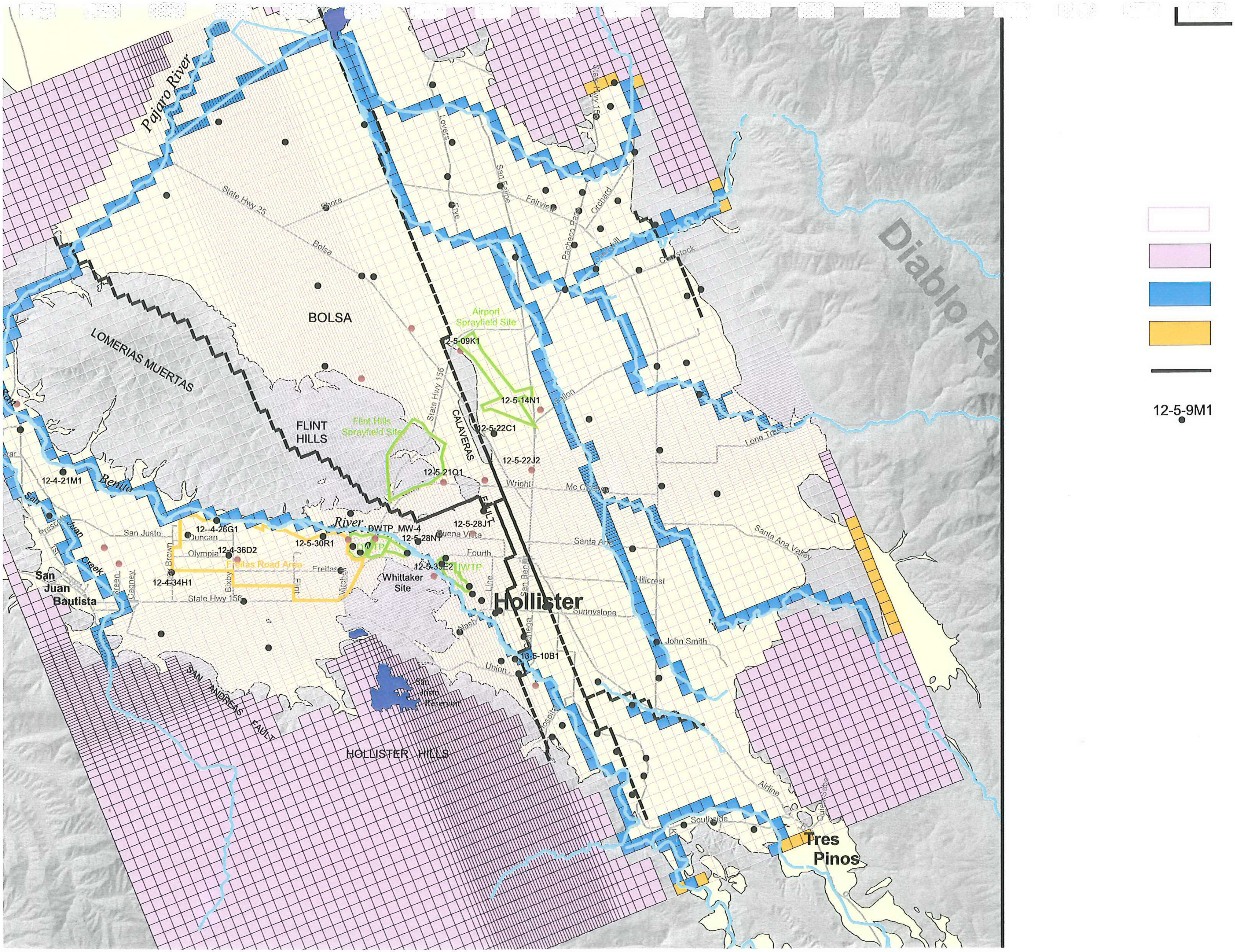
- The grid spacing was decreased in the vicinity of the DWTP and IWTP in order to provide greater detail in simulated water table mounding beneath the percolation ponds.
- The model was divided into five layers in order to represent vertical differences in water levels and salinity. The upper surface of the top layer (layer 1) was shaped to parallel the relatively low water table surface at the start of the calibration period. This helps prevent layer 1 cells from going dry when simulated water levels fall below the bottom elevation of layer 1.
- The original calibration period was January 1993 to September 2000. This was extended through September 2003. The model uses quarterly time intervals for transient simulations.
- The active part of the flow domain was expanded to include the Lomerias Muertas/Flint Hills area and the Hollister Hills area that projects north from near San Justo Reservoir. Subsurface permeability is lower in these hilly areas than in the valley floor areas, but they are all part of a single, continuous groundwater flow system. The original model had excluded these areas. They were added to the model in order to explore potential impacts on the groundwater contaminant plume at the former Whittaker ordnance facility and on groundwater flow and salinity near the proposed Flint Hills sprayfield site.
- The simulation of salt loading was completely revised to include separate loads from individual sources (stream percolation; wastewater percolation; recharge from rainfall and irrigation water, etc.) and to simulate loads on a transient basis. Salt loading by deep percolation of infiltrated rainfall and irrigation water was converted to a spatially variable input by calibrating a "background mass load" based on local groundwater salinity and irrigation water salinity. The background mass load represents all sources of dissolved solids in the deep percolation other than irrigation water (gypsum, fertilizers, atmospheric deposition and dissolution of soil minerals) and was calibrated so that simulated deep percolation salinity equaled shallow groundwater salinity. Shallow groundwater salinity was set equal to the average of ten shallow wells in the San Juan Valley (2,330 mg/l) because spatial variability and lack of data in other parts of the basin precluded regional contouring of shallow groundwater salinity. However, measured TDS concentrations in shallow wells near the DWTP, IWTP and airport were included as localized areas of detail.

- Recharge zones for future simulations were revised to conform to the 2002 land use survey completed by the California Department of Water Resources and to include separate zones for wastewater disposal and reuse areas. The model calibration period was simulated using the 1997 land use survey.
- The recharge preprocessor was modified to account for recharge on peripheral hills that are not included in the active part of the model flow domain.
- Mathematical functions relating stream depth, width and dissolved-solids concentration to stream flow were greatly improved based on new field data collected by SBCWD in 2004.
- The MODPATH extension to the MODFLOW model code was implemented to simulate the Whittaker contaminant plume path
- The ZONEBUDGET extension to MODFLOW was implemented to obtain water budget information for sub-regions of the model flow domain.
- Inflow to the basin through alluvium along creeks (Pacheco Creek, Arroyo de las Viboras, Arroyo Dos Picachos, Tres Pinos Creek and the San Benito River was represented by general-head boundaries. Inflow beneath the Pajaro River from the Llagas area was similarly represented. The conductance terms for these inflows were calibrated to obtain reasonable inflow rates comparable to the estimated inflows in water budgets developed for SBCWD annual groundwater reports.
- The model was completely recalibrated. This included redefining zones of hydraulic conductivity and storativity, adjusting their parameter values, adjusting the locations and conductances of faults, and adjusting streambed permeability. Shallow wells were added to the calibration data set to support calibration of vertical hydraulic conductivity.

Hydrographs of simulated and measured water levels at 16 of the 106 well locations used for model calibration are shown in **Figure A-2**. These are wells located in areas that would be affected by the wastewater system improvements project, and their locations are labeled in **Figure A-1**.

The model uses quarterly stress periods and was calibrated to measured groundwater levels and stream-aquifer fluxes during 1993-2003. Calibration of the flow component of the model is good in all subbasins.

The ability of the solute transport component of the model to correctly simulate existing TDS concentration at any point in the basin is limited. Salinity data are fairly sparse, especially for shallow aquifers. Available data show considerable spatial variability geographically and with depth. Because of this variability, contoured initial concentrations for deep aquifers (model layers two through five) are not highly reliable except near the measurement wells. There were too few points to allow regional contouring of salinity in shallow aquifers (model layer 1), instead an initial concentration equal to the average of all available measurements was used in all parts of the basin except areas near the DWTP, IWTP and airport, for which one or more measured values were available. The solute transport model also simplifies water quality processes by lumping all salt loads other than irrigation water into a single background mass load term that was calibrated using an assumption that existing shallow groundwater salinity is in equilibrium with recharge salinity. Because of these simplifying assumptions, the solute transport component of the model is primarily useful for comparing relative differences among alternatives rather than predicting absolute TDS concentrations.



Pajaro River
BOLSA
LOMERIAS MUERTAS
FLINT HILLS
CALAVERAS FAULT
Diablo Ra
San Benito River
San Juan Creek
San Juan Bautista
Hollister
Tres Pinos
HOLLISTER HILLS
SAN ANDREAS FAULT
San Justo Reservoir
Whittaker Site
Airport Sprayfield Site
Flint Hills Sprayfield Site
Freitas Road Area
DWTP
IWTP
State Hwy 25
State Hwy 156
Shore
Bolsa
Lovers
San Felipe
Frazer
Fairview
Pacheco Pass
Orchard
Comstock
Fallon
Lone Tree
Wright
Mc Closkey
Santa Ana
Santa Ana Valley
Hillcrest
Sunnyslope
John Smith
Union
Nash
Line
San Benito
Fourth
Buena Vista
San Justo
Duncan
Olympia
Freitas
Brown
Bixby
Flint
Mitchell
Green
Cagney
Prescott
Airline
Southside
Quien Sabe
Hospital
12-5-09K1
12-5-14N1
12-5-22C1
12-5-22J2
12-5-21Q1
12-5-28J1
12-5-28N1
DWTP_MW-4
12-5-30R1
12-5-33E2
12-4-26G1
12-4-36D2
12-4-34H1
12-4-21M1
13-5-10B1
12-5-9M1

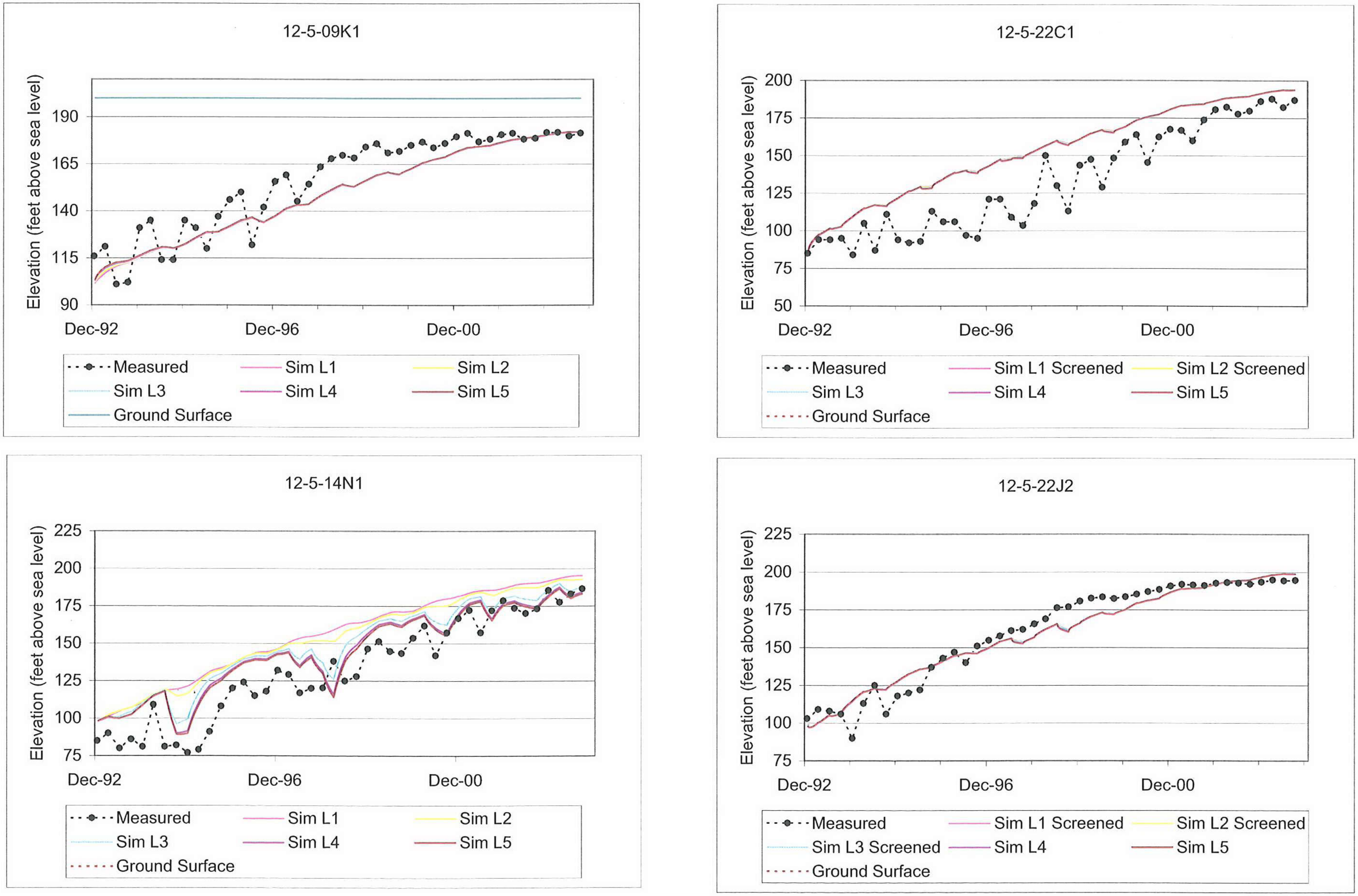


Figure A-2. Simulated and Measured Groundwater Levels for the 1993-2003 Calibration Simulation at Selected Locations Potentially Affected by the Proposed Project

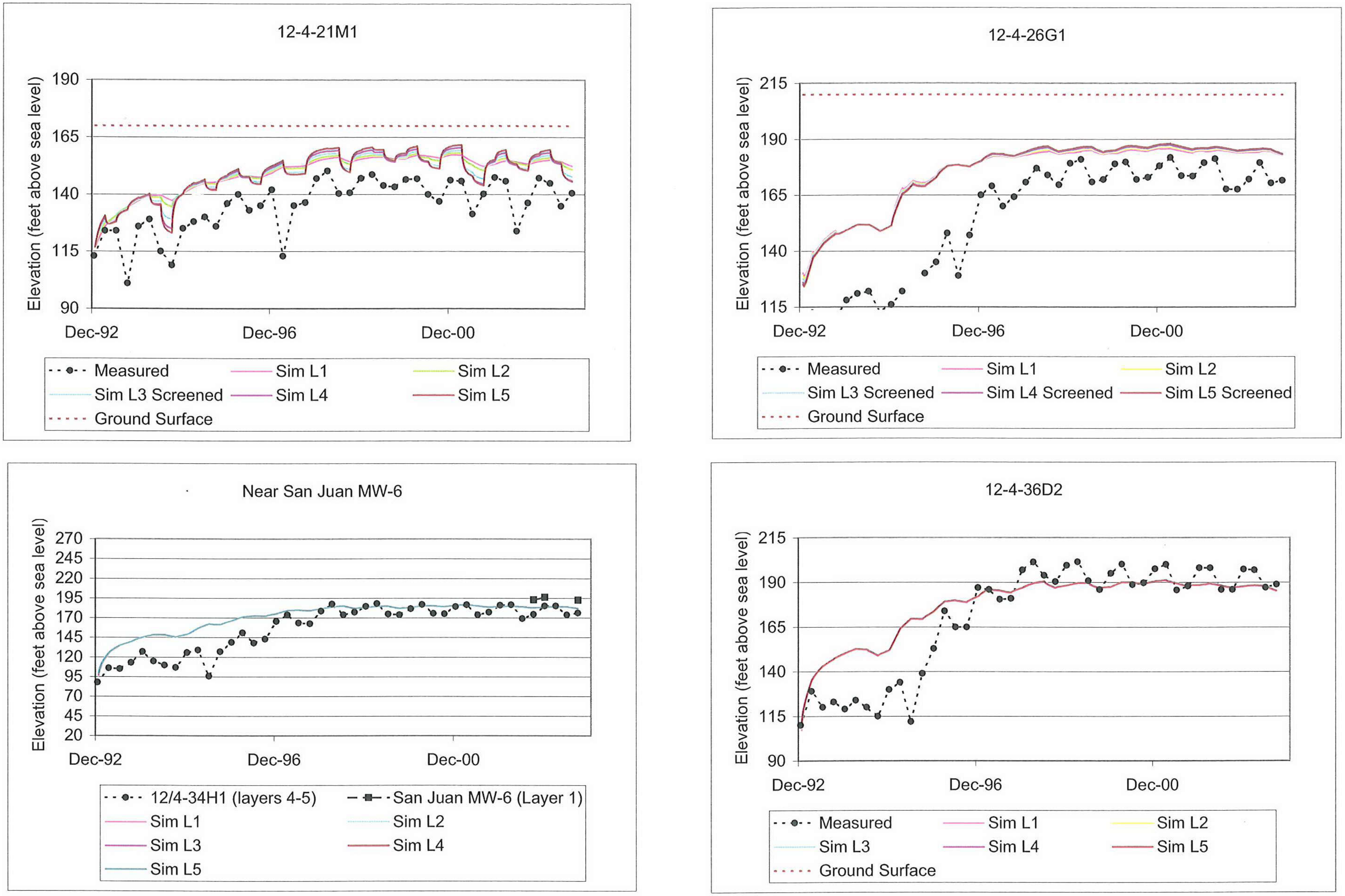


Figure A-2 — continued

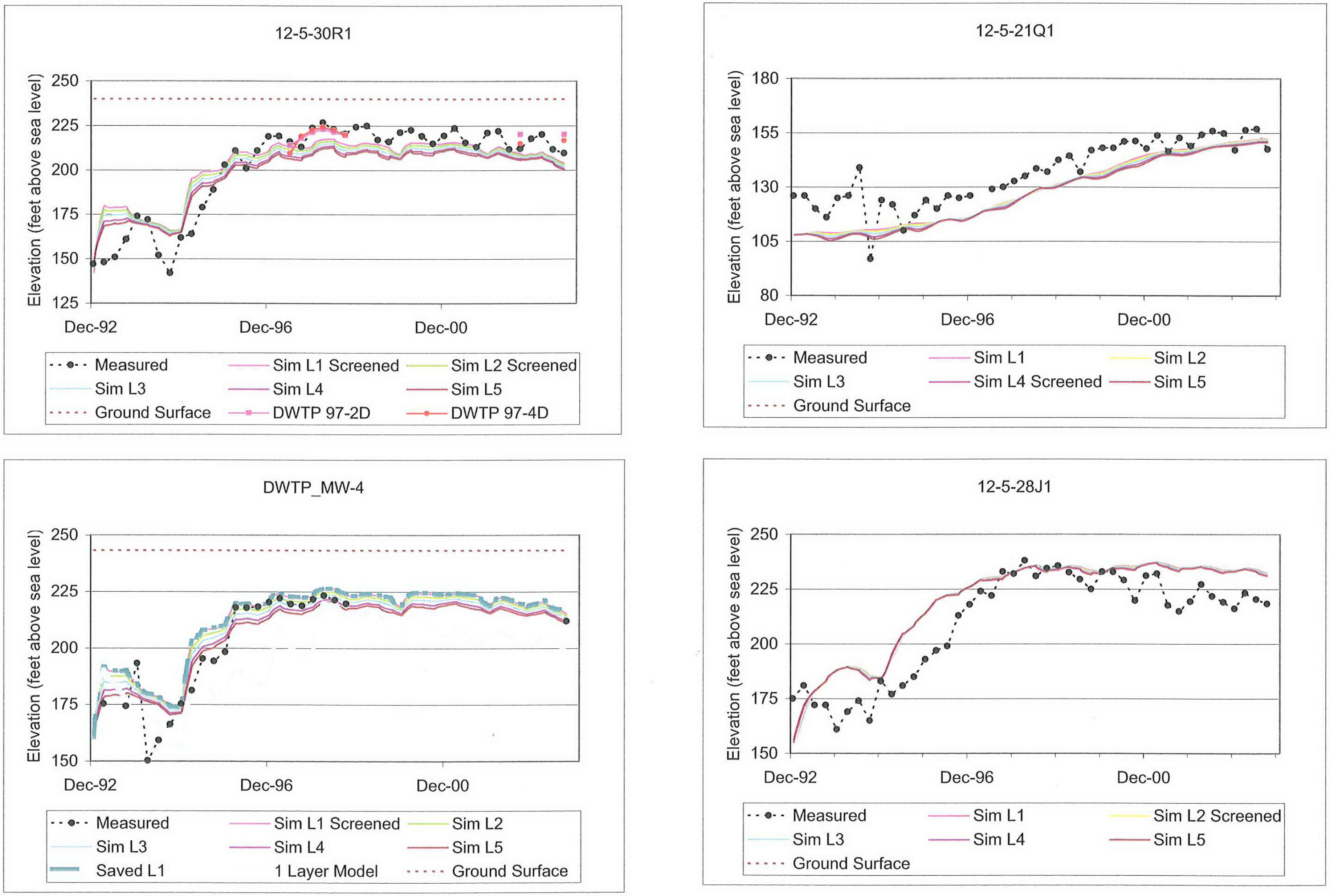
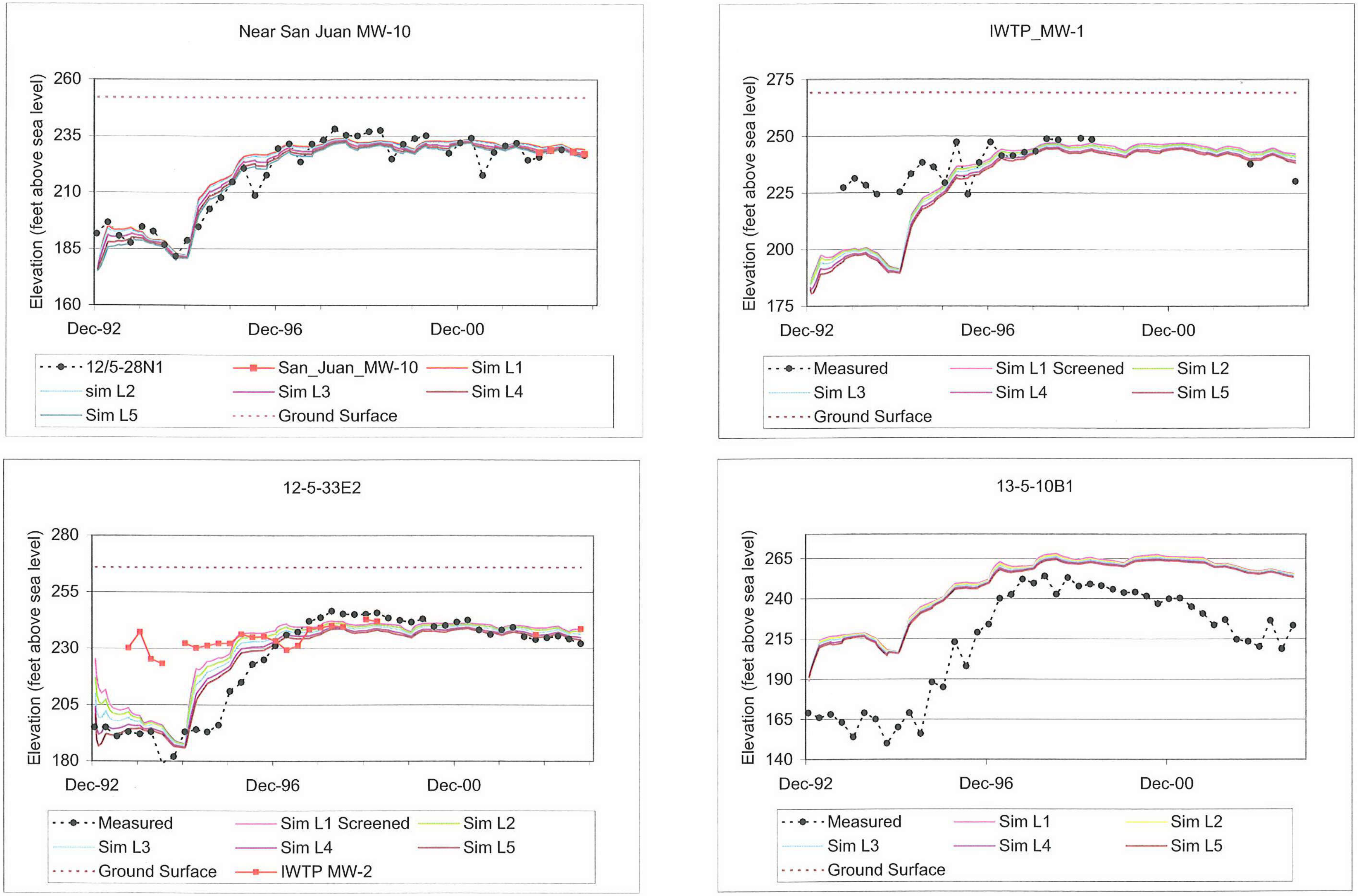


Figure A-2 — continued



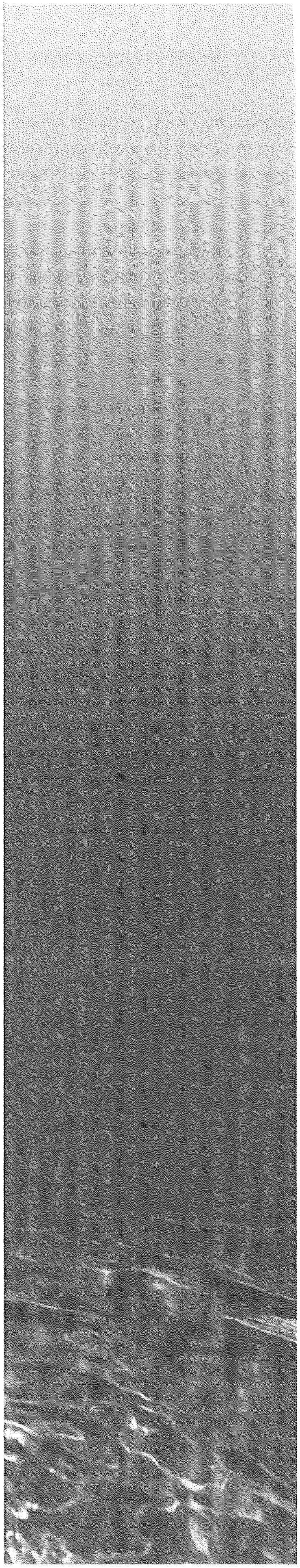
Near San Juan MW-10

IWTP_MW-1

12-5-33E2

13-5-10B1

Figure A-2 — continued



Appendix C

Treatment Process Vendor Proposals

Pajaro River Watershed Groundwater Desalination Feasibility Study

Severn-Trent Reverse Osmosis BW30-400 System

Reverse Osmosis System Analysis for FILMTEC™ Membranes | ROSA v6.0 ConfigDB 35240039
Project: Everpure RMC Water | Case: 1
Chad Dannemann, Severn Trent Services | 5/15/2006

Project Information:

System Details

Feed Flow to Stage 1	926.00 gpm	Pass 1 Permeate Flow	694.56 gpm	Osmotic Pressure:	
Raw Water Flow to System	926.00 gpm	Pass 1 Recovery	75.01 %	Feed	15.88 psig
Feed Pressure	198.03 psig	Feed Temperature	25.0 C	Concentrate	59.73 psig
Fouling Factor	0.85	Feed TDS	1900.13 mg/l	Average	37.80 psig
Chem. Dose	None	Number of Elements	168	Average NDP	132.07 psig
Total Active Area	67200.00 ft2	Average Pass 1 Flux	14.88 gfd	Power	99.72 kW
Water Classification: Well Water SDI < 3				Specific Energy	2.39 kWh/kgal

Stage	Element	#PV	#Ele	Feed Flow (gpm)	Feed Press (psig)	Recirc Flow (gpm)	Conc Flow (gpm)	Conc Press (psig)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psig)	Boost Press (psig)	Perm TDS (mg/l)
1	BW30-400	16	7	926.00	193.03	0.00	397.98	161.03	528.02	16.97	0.00	0.00	20.02
2	BW30-400	8	7	397.98	156.03	0.00	231.44	126.73	166.55	10.71	0.00	0.00	60.78

Pass Streams
(mg/l as Ion)

Name	Feed	Adjusted Feed	Concentrate		Permeate		
			Stage 1	Stage 2	Stage 1	Stage 2	Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	5.70	5.70	12.73	21.05	0.40	1.16	0.59
Na	354.00	354.00	817.94	1396.82	4.31	13.49	6.52
Mg	105.00	105.00	243.46	417.27	0.63	1.93	0.95
Ca	88.10	88.10	204.29	350.16	0.52	1.60	0.78
Sr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3	0.67	0.67	4.59	15.74	0.00	0.00	0.00
HCO3	641.00	641.00	1474.24	2500.95	8.66	25.44	12.63
NO3	6.00	6.00	13.16	21.39	0.60	1.73	0.87
Cl	325.00	456.33	1056.64	1808.16	3.85	12.29	5.88
F	0.33	0.33	0.76	1.30	0.00	0.01	0.01
SO4	243.00	243.00	564.03	967.66	1.03	3.12	1.53
Boron	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SiO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO2	83.01	82.36	84.09	88.87	82.48	85.35	83.20
TDS	1771.26	1900.13	4391.85	7500.50	20.02	60.78	29.74
pH	6.93	6.93	7.22	7.37	5.22	5.66	5.38

Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area. DISCLAIMER: NO WARRANTY, EXPRESSED OR IMPLIED,AND NO WARRANTY OF MERCHANTABILITY OR FITNESS, IS GIVEN. Neither FilmTec Corporation nor The Dow Chemical Company assume liability for results obtained or damages incurred from the application of this information. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.

Design Warnings

-None-

Solubility Warnings

Langelier Saturation Index > 0
Stiff & Davis Stability Index > 0
Antiscalants may be required. Consult your antiscalant manufacturer for dosing and maximum allowable system recovery.

Stage Details

Stage 1 Element	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.09	5.39	11.95	57.88	1900.13	193.03
2	0.10	5.14	13.85	52.48	2094.02	186.06
3	0.10	4.91	16.18	47.34	2319.84	180.02
4	0.11	4.70	19.08	42.43	2586.23	174.81
5	0.12	4.49	22.74	37.74	2905.40	170.38
6	0.13	4.29	27.44	33.25	3294.29	166.65
7	0.14	4.09	33.64	28.96	3777.74	163.56

Stage 2 Element	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.08	3.79	38.33	49.75	4391.85	156.03
2	0.08	3.51	44.50	45.96	4750.54	150.33
3	0.08	3.24	51.85	42.44	5139.52	145.23
4	0.08	2.97	60.66	39.20	5559.21	140.68
5	0.07	2.70	71.34	36.23	6008.85	136.61
6	0.07	2.43	84.37	33.53	6485.81	132.96
7	0.07	2.17	100.40	31.10	6985.39	129.68

Permeate Flux reported by ROSA is calculated based on ACTIVE membrane area. DISCLAIMER: NO WARRANTY, EXPRESSED OR IMPLIED,AND NO WARRANTY OF MERCHANTABILITY OR FITNESS, IS GIVEN. Neither FilmTec Corporation nor The Dow Chemical Company assume liability for results obtained or damages incurred from the application of this information. FilmTec Corporation and The Dow Chemical Company assume no liability, if, as a result of customer's use of the ROSA membrane design software, the customer should be sued for alleged infringement of any patent not owned or controlled by the FilmTec Corporation nor The Dow Chemical Company.

Scaling Calculations

	Raw Water	Adjusted Feed	Concentrate
pH	6.93	6.93	7.37
Langelier Saturation Index	0.05	0.05	1.65
Stiff & Davis Stability Index	0.20	0.18	1.26
Ionic Strength (Molal)	0.04	0.04	0.15
TDS (mg/l)	1771.26	1771.26	7500.50
HCO3	641.00	641.00	2500.95
CO2	83.00	82.35	88.84
CO3	0.67	0.67	15.74
CaSO4 (% Saturation)	3.51	3.43	21.91
BaSO4 (% Saturation)	0.00	0.00	0.00
SrSO4 (% Saturation)	0.00	0.00	0.00
CaF2 (% Saturation)	1.28	1.28	78.50
SiO2 (% Saturation)	0.00	0.00	0.00
Mg(OH)2 (% Saturation)	0.00	0.00	0.01

To balance: 131.33 mg/l Cl added to feed.

Severn-Trent Reverse Osmosis XLE-440 System

Reverse Osmosis System Analysis for FILMTEC™ Membranes
Project: Everpure RMC Water
Chad Dannemann, Severn Trent Services

ROSA v6.0 ConfigDB 35240039
Case: 2
5/15/2006

Project Information:

System Details

Feed Flow to Stage 1	926.08 gpm	Pass 1 Permeate Flow	694.41 gpm	Osmotic Pressure:	
Raw Water Flow to System	926.08 gpm	Pass 1 Recovery	74.98 %	Feed	15.88 psig
Feed Pressure	119.54 psig	Feed Temperature	25.0 C	Concentrate	57.69 psig
Fouling Factor	0.85	Feed TDS	1900.13 mg/l	Average	36.78 psig
Chem. Dose	None	Number of Elements	168	Average NDP	56.30 psig
Total Active Area	73920.00 ft2	Average Pass 1 Flux	13.53 gfd	Power	60.21 kW
Water Classification: Well Water SDI < 3				Specific Energy	1.45 kWh/kgal

Stage	Element	#PV	#Ele	Feed Flow (gpm)	Feed Press (psig)	Recirc Flow (gpm)	Conc Flow (gpm)	Conc Press (psig)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psig)	Boost Press (psig)	Perm TDS (mg/l)
1	XLE-440	16	7	926.08	114.54	0.00	331.73	88.86	594.35	17.37	0.00	0.00	67.10
2	XLE-440	8	7	331.73	83.86	0.00	231.67	61.73	100.06	5.85	0.00	0.00	332.21

Pass Streams (mg/l as Ion)							
Name	Feed	Adjusted Feed	Concentrate		Permeate		
			Stage 1	Stage 2	Stage 1	Stage 2	Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
K	5.70	5.70	13.75	17.88	1.21	4.20	1.64
Na	354.00	354.00	960.09	1340.38	15.72	79.62	24.93
Mg	105.00	105.00	288.89	408.62	2.36	11.70	3.71
Ca	88.10	88.10	242.48	343.01	1.93	9.74	3.06
Sr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO3	0.67	0.67	6.78	14.88	0.00	0.01	0.00
HCO3	641.00	641.00	1743.93	2443.84	20.00	99.10	31.36
NO3	6.00	6.00	13.56	16.85	1.78	5.93	2.38
Cl	325.00	456.33	1237.69	1727.96	20.23	102.59	32.10
F	0.33	0.33	0.89	1.24	0.02	0.09	0.03
SO4	243.00	243.00	671.49	953.20	3.85	19.24	6.07
Boron	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SiO2	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CO2	83.01	82.36	85.08	88.49	82.74	85.94	83.22
TDS	1768.80	1900.13	5179.57	7267.87	67.10	332.21	105.27
pH	6.93	6.93	7.27	7.36	5.56	6.19	5.74

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Design Warnings

WARNING: Maximum recommended element permeate flow rate has been exceeded. Please change your system design to reduce the element permeate flows. (Product: XLE-440, Limit: 6.94gpm)

Solubility Warnings

Langelier Saturation Index > 0
Stiff & Davis Stability Index > 0
Antiscalants may be required. Consult your antiscalant manufacturer for dosing and maximum allowable system recovery.

Stage Details

Stage 1 Element	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.12	7.05	31.82	57.88	1900.13	114.54
2	0.13	6.42	39.89	50.83	2159.04	108.38
3	0.13	5.83	50.46	44.41	2465.17	103.27
4	0.14	5.28	64.49	38.58	2830.04	99.07
5	0.14	4.73	83.33	33.30	3267.72	95.64
6	0.15	4.19	109.04	28.57	3794.52	92.86
7	0.15	3.65	144.74	24.38	4427.40	90.64

Stage 2 Element	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.07	2.97	184.07	41.47	5179.57	83.86
2	0.06	2.49	229.54	38.49	5564.54	79.87
3	0.06	2.06	287.10	36.01	5932.56	76.25
4	0.05	1.68	359.92	33.95	6273.96	72.95
5	0.04	1.36	451.94	32.27	6581.23	69.89
6	0.04	1.09	566.82	30.91	6849.59	67.02
7	0.03	0.87	707.33	29.82	7077.83	64.32

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Scaling Calculations

	Raw Water	Adjusted Feed	Concentrate
pH	6.93	6.93	7.36
Langelier Saturation Index	0.05	0.05	1.62
Stiff & Davis Stability Index	0.20	0.18	1.25
Ionic Strength (Molal)	0.04	0.04	0.15
TDS (mg/l)	1768.80	1768.80	7267.87
HCO3	641.00	641.00	2443.84
CO2	83.00	82.35	88.47
CO3	0.67	0.67	14.88
CaSO4 (% Saturation)	3.51	3.43	21.63
BaSO4 (% Saturation)	0.00	0.00	0.00
SrSO4 (% Saturation)	0.00	0.00	0.00
CaF2 (% Saturation)	1.28	1.28	69.80
SiO2 (% Saturation)	0.00	0.00	0.00
Mg(OH)2 (% Saturation)	0.00	0.00	0.01

To balance: 131.33 mg/l Cl added to feed.

Ionics Electrodialysis Reversal EDR-2020 System

GE Infrastructure
Water & Process Technologies

Eugene R. Reahl
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May 22, 2006

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Watertown, MA

SUB: **UPDATED INFORMATION FOR SAN BENITO**

REF: Your Inquiry of 5/08/2006

As discussed at your office back in April, both RO and EDR could be investigated for this 1 mgd and 2 mgd potential project. The driver on this project, as we remember, is water recovery for reduced ponding of brines, and higher utilization of the ground water supply.

For RO, the main driver on water recovery will be the level of silica in the groundwater. For EDR, it will be the concentrated scaling factors of CaCO3 (Langelier Index), BaSO4, etc. EDR will generate a higher level of brine concentration compared to RO.

In looking at the water analysis data we have, there is no silica called out. There is no boron called out either. We assumed various levels of silica, to see what RO water recovery would be. Then, we looked at the blending ratios of RO product : bypass of raw water to achieve a 450 ppm TDS final product. **Assuming a 1 mgd** total blended usage, the overview of all this at assumed silica levels of 25 ppm, 40 ppm and 55 ppm shows the **following flows in gpd**

	RO			**EDR**
	25 ppm	40 ppm	55 ppm	
Total Blended Water	----- 1,000,000 gpd -----			1,000,000 gpd
Membrane Product	----- 800,000 ---- --			900,000
Bypass Flow	------ 200,000 ------			100,000
Waste To Ponds	**141,00**	**200,000**	**247,000**	**100,000**

Since EDR does not remove silica, it is not affected by it, and all the silica possibilities do not impact EDR

If the total flow is 2 mgd, the above flows are doubled.

In essence, the RO water recoveries are affected by the assumed silica in the feedwater, as follows:

25 ppm SiO2 = 85% Water Recovery
40 ppm SiO2 = 80% Water Recovery
55 ppm SiO2 = 75% Water Recovery

For this quick workup, **at 1 mgd**, we have assumed 3 each, 50% capacity membrane desalination units. To correspond this to the closest standard GE reverse osmosis or EDR system we picked

3 ea, MUNI 300 Premium RO Units	(300 gpm each)
3 ea, EDR 2020 (3/3) units	(312 gpm each)

At **1 mgd**, the capital cost estimate is:

	RO	**EDR**
Membrane System	$950,000	$2,060,000
Installation	$125,000	$ 220,000
Building Req'd ($100/sq-ft)	$200,000	$ 450,000
Miscellaneous (bypass +)	$ 50,000	$ 50,000
Sub-Total $	$1,325,000	$2,780,000

For a **2 mgd plant**, either more of the smaller (300 gpm) RO units could be used, or larger 450 gpm systems installed. For redundancy, we would show 4 ea, 450 gpm units, with max 3 on-line and 1 in reserve/standby. With EDR, the same units would be used, only expanded from 450,000 gpd each to 900,000 gpd each by adding more parallel lines of membrane stacks.

The corresponding costs (as above) for the equipment, installation, building, and miscellaneous items would be:

RO	**EDR**
$1,700,000	$3,325,000

These prices include competent engineering for interface with the project, with at least one multi disciplined project engineering visit to site, help with equipment layout and building design, a pre-installation meeting from field-service engineers, and supervision of installation, training, startup, performance testing and follow up service (check out) visits. These prices do not include freight to site, taxes, site prep, other equipment costs, water storage, brine disposal, nor engineering, architectural, and other fees and costs.

The above numbers can be visited again later – for now they show a comparison of capital costs for the savings EDR offers in reduced waste flow disposal.

For an estimate of the O&M costs, the following applies to both 1 mgd and 2 mgd examples. For the RO system, we have assumed a nominal 80% water recovery. We have assumed electrical power at 12 cents per KWHr.

		O&M Costs In Dollars Per 1,000 Gallons Of Product **	
		RO	EDR
1.	**Consumables**		
	a. Electrical Power	$0.500	$0.480
	b. Chemicals Used	$0.060	$0.040
	c. Replace Filter Cartridges	$0.040	$0.040
	Sub-Total	$0.600	$0.560
2.	**Long-Term Reserves**		
	a. Membrane Replacement	$0.120	$0.095
	b. Other Parts Replacement	$0.050	$0.050
	Sub-Total	$0.170	$0.145
3.	**Sub-Total O&M Costs**	$0.770	$0.705
4.	**Effective Cost With Blending** (RO @ 80%, EDR @ 90%)	**$0.616**	**$0.645**

** 1. These costs assume a minimum 20 psi incoming feedwater pressure from the wellhead. This allows the RO system to eliminate initial pressurization before filter cartridges. For EDR, it downsizes the needed feedpumps.

2. The labor costs have not been included. For each process we assume 2.5 hrs per day of operator attention, and 2 hrs per day, (amortized) long-term maintenance labor on the facility. These figures do not include building and other water infrastructure labor requirements

In the water data presented, iron was shown as 0.6 ppm. If this iron is dissolved, and remains so, no pretreatment would be needed. If the iron is oxidized, additional pretreatment, before either RO or EDR should be installed to not overload the disposable filter cartridges. The cost of this additional treatment (with backwash pumping, chemical feed, etc) is estimated at:

1 mgd	2 mgd

EDR	$375,000	$500,000
RO	$395,000	$520,000

An additional 15 – 20 psi from the wellhead (in addition to the assumed 20 psi from the above examples) would be needed to insure the raw water gets through the iron filters (either multi-media with chlorine feed in front, or manganese greensand with KMNO4 feed in front). For the RO system, additional chemical feed and control has to be added to protect the RO membranes. EDR will not require this. The O&M cost for water treatment would go up by the additional wellhead pump pressure required, and the estimated $0.01/1,000 gallons for filter chemical treatment.

The raw water data did not include boron. This may, or may not be an issue at this site. If boron is present, in amounts high enough to warrant State of California DHS concern, both the RO and EDR treatment schemes have to be rethought. The RO system would get more complicated. Perhaps the easiest way to treat for this would be to post treat a portion of both the RO and the EDR product with specialty ion-exchange resins, specifically designed for boron removal.

With both iron removal filters and post treatment for boron, additional wastewater disposal volume is required.

In summing up, we would recommend that your client (or RMC) contact the test lab in Hollister to see of they still have samples on hand.

HAVE THEM TEST FOR

SILICA....................................reactive and non-reactive (dissolved and colloidal)
BORON

To get a final handle on how to treat this water, the most effectively, these constituents must be known.

They should also retest for barium..........to get THE ACTUAL number that they report for < 0.100 ug/liter.

Hope this all helps meet your needs.

- - - gene reahl - - - -

Severn-Trent Nanofiltration NF-90 System

Reverse Osmosis System Analysis for FILMTEC™ Membranes	ROSA v6.1 ConfigDB 35240041
Project: Everpure RMC	Case: 1
Chad Dannemann, Severn Trent Services	5/19/2006

Project Information:

System Details

Feed Flow to Stage 1	1024.83 gpm	Pass 1 Permeate Flow	693.50 gpm	Osmotic Pressure:	
Raw Water Flow to System	924.83 gpm	Pass 1 Recovery	74.99 %	Feed	15.61 psig
Feed Pressure	105.67 psig	Feed Temperature	20.0 C	Concentrate	55.04 psig
Fouling Factor	0.85	Feed TDS	1900.14 mg/l	Average	35.33 psig
Chem. Dose (100% H2SO4)	0.00 mg/l	Number of Elements	168	Average NDP	54.13 psig
Total Active Area	67200.00 ft²	Average Pass 1 Flux	14.86 gfd	Power	58.89 kW
Water Classification: Well Water SDI < 3				Specific Energy	1.42 kWh/kgal

Stage	Element	#PV	#Ele	Feed Flow (gpm)	Feed Press (psig)	Recirc Flow (gpm)	Conc Flow (gpm)	Conc Press (psig)	Perm Flow (gpm)	Avg Flux (gfd)	Perm Press (psig)	Boost Press (psig)	Perm TDS (mg/l)
1	NF90-400	24	7	1024.83	100.67	100.00	331.33	82.23	693.50	14.86	0.00	0.00	167.03

Pass Streams (mg/l as Ion)						
Name	Feed	Adjusted Feed		Concentrate	Permeate	
		Initial	After Recycles	Stage 1	Stage 1	Total
NH4	0.00	0.00	0.00	0.00	0.00	0.00
K	5.70	5.70	6.70	15.64	2.42	2.42
Na	354.00	354.00	445.70	1284.96	44.73	44.73
Mg	105.00	105.00	134.57	407.14	4.35	4.35
Ca	88.10	88.10	112.94	341.87	3.56	3.56
Sr	0.00	0.00	0.00	0.00	0.00	0.00
Ba	0.00	0.00	0.00	0.00	0.00	0.00
CO3	0.60	0.60	1.04	12.71	0.00	0.00
HCO3	641.00	641.00	815.91	2408.98	45.64	45.64
NO3	6.00	6.00	6.79	13.79	3.45	3.45
Cl	325.00	456.42	574.52	1655.34	58.14	58.14
F	0.33	0.33	0.41	1.17	0.05	0.05
SO4	243.00	243.00	312.87	957.92	4.69	4.69
SiO2	0.00	0.00	0.00	0.00	0.00	0.00
Boron	0.00	0.00	0.00	0.00	0.00	0.00
CO2	89.13	89.13	89.11	94.28	89.93	89.91
TDS	1768.73	1900.14	2411.46	7099.52	167.03	167.03
pH	6.93	6.93	7.01	7.36	5.89	5.89

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Reverse Osmosis System Analysis for FILMTEC™ Membranes
Project: Everpure RMC
Chad Dannemann, Severn Trent Services

ROSA v6.1 ConfigDB 35240041
Case: 1
5/19/2006

Design Warnings

-None-

Solubility Warnings

Langelier Saturation Index > 0
Stiff & Davis Stability Index > 0
Antiscalants may be required. Consult your antiscalant manufacturer for dosing and maximum allowable system recovery.

Stage Details

Stage 1 Element	Recovery	Perm Flow (gpm)	Perm TDS (mg/l)	Feed Flow (gpm)	Feed TDS (mg/l)	Feed Press (psig)
1	0.14	6.00	75.09	42.70	2411.46	100.67
2	0.15	5.35	96.08	36.70	2793.23	95.97
3	0.15	4.72	124.59	31.35	3253.12	92.19
4	0.15	4.10	164.08	26.63	3807.00	89.17
5	0.15	3.49	219.84	22.53	4469.29	86.79
6	0.15	2.90	299.48	19.04	5246.98	84.90
7	0.14	2.34	413.47	16.14	6132.80	83.42

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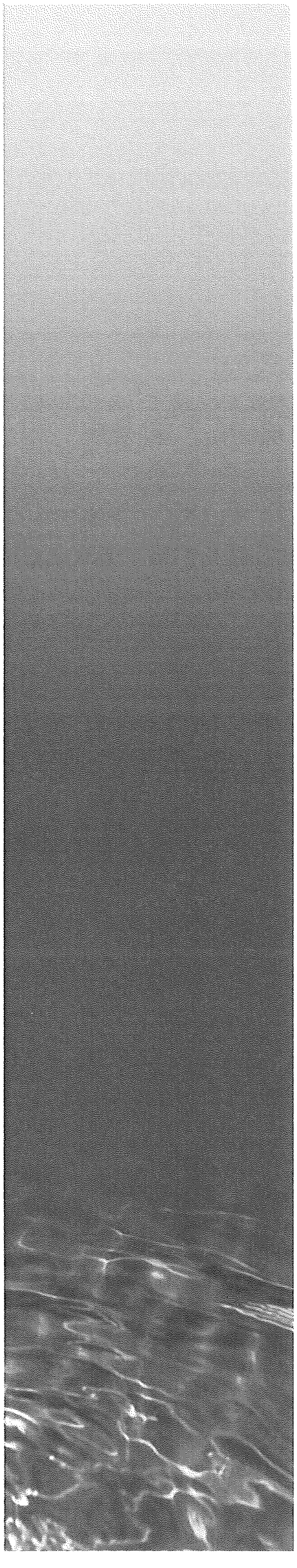
Scaling Calculations

	Raw Water	Adjusted Feed	Concentrate
pH	6.93	6.93	7.36
Langelier Saturation Index	-0.06	-0.06	1.50
Stiff & Davis Stability Index	0.11	0.11	1.15
Ionic Strength (Molal)	0.04	0.04	0.14
TDS (mg/l)	1768.73	1900.14	7099.52
HCO3	641.00	641.00	2408.98
CO2	89.12	89.12	94.25
CO3	0.60	0.60	12.71
CaSO4 (% Saturation)	3.51	3.51	21.99
BaSO4 (% Saturation)	0.00	0.00	0.00
SrSO4 (% Saturation)	0.00	0.00	0.00
CaF2 (% Saturation)	1.28	1.28	62.45
SiO2 (% Saturation)	0.00	0.00	0.00
Mg(OH)2 (% Saturation)	0.00	0.00	0.01

To balance: 131.42 mg/l Cl added to feed.



Appendix D

Pilot Testing Summary Technical Memorandum

Pajaro River Watershed Groundwater Desalination Feasibility Study

Technical Memorandum

Pajaro River Watershed Groundwater Desalination Feasibility Study

Subject: **Pilot Testing Summary**

Prepared For: Project Partners

Prepared by: Matt Van Horne, Marina Bronstein-Grouchnikov (RMC)

Reviewed by: Stephanie Hughes (RMC)

Date: August 20, 2007

Reference: 076-009 Task 3/076-012 Task 2

The purpose of this technical memorandum (TM) is to document the process and results from the pilot testing that accompanied the Pajaro River Watershed Groundwater Desalination Feasibility Study. This TM presents the pilot testing information and is organized as follows:

1 Introduction 1
2 Pilot Testing Procedure 2
  2.1 Feed Water Source 2
  2.2 Pilot Unit Equipment 3
  2.3 Monitoring and Sampling 3
3 Testing Results 4
  3.1 Cleaning Periods 4
  3.2 Flow Rates & Water Recovery 5
  3.3 TDS Concentrations and Removals 8
  3.4 Water Sampling Results 9
  3.5 RO Feed Pressure 11
4 Operations and Maintenance Lessons 12
  4.1 Power Failures 12
  4.2 Instrument Cleaning 12
  4.3 Preliminary Cartridge Filters 13
5 Conclusions 13

1 Introduction

In October 2006, a reverse osmosis (RO) pilot system was installed on a brackish groundwater well in the San Juan Valley, west of the City of Hollister. The specific RO system used was a part of the Desalination Research Innovation Partnership (DRIP) project awarded by the California Department of Water Resources and the Metropolitan Water District of Southern California to Santa Clara Valley Water District (SCVWD) and Stanford University (Stanford). The San Benito County Water District (SBCWD) coordinated with the City of Hollister (owner of the pilot site location), served as lead agency for procurement of the additional equipment and services needed to set up the unit, and obtained a low-threat discharge permit from the Central Coast Regional Water Quality Control Board (RWQCB) for disposal of blended permeate and concentrate flows from the pilot unit.

The main goals of the pilot testing were to:

- Provide an additional site for inclusion in the DRIP program to assist the SCVWD/Stanford team in meeting their goals of determining the economic viability of desalination of brackish groundwater, evaluating the performance of RO membranes in an actual installation and studying fouling characteristics through membrane autopsies.

- Determine the technical feasibility of RO treatment of brackish groundwater in the San Juan Valley.
- Identify any major operational or maintenance difficulties resulting from desalination of San Juan Valley groundwater.
- Gather preliminary data on the effectiveness of RO treatment on the quality of the groundwater.

Following installation, the pilot treatment system operated sporadically through October and November 2006 due to frequent problems with power supply reliability and its impact on the membrane system. From December 2006 through February 2007, the unit was largely non-operational as modifications were made to the unit to allow it to overcome the local power supply variations and provide data recording needed to determine the feasibility of groundwater demineralization in the San Juan Valley. Focused testing throughout March and April 2007 provided eight weeks of comprehensive data on the RO system performance. These eight weeks of data provide the basis for evaluation of the feasibility of brackish groundwater desalination in the San Juan Valley.

2 Pilot Testing Procedure

The pilot testing procedure was developed by Stanford and mainly consisted of automated operation of the RO unit. Operator attention was provided on an "as-needed" basis to correct problems and to perform general maintenance. The following sections summarize the main characteristics of the unit's operation and data collections.

2.1 Feed Water Source

The feed water supply was an unused agricultural well located on the western portion of the City of Hollister Domestic Wastewater Treatment Plant site. The location of the well and the observed water quality indicate that the nearby wastewater disposal ponds may have some degree of influence on the local water quality. However, the critical water quality parameters were relatively consistent with the overall quality around the San Juan Valley, thus providing general information on the feasibility of groundwater demineralization in this area. A water sample taken prior to the testing period returned a water analysis summarized in Table 2-1.

Table 2-1: Feed Water Analysis

Analyte	Value	Analyte	Value
Hardness	653 mg/L	Color	10 units
Calcium	88.1 mg/L	Turbidity	3.12 NTU
Magnesium	105 mg/L	Aluminum	< 50 μg/L
Sodium	354 mg/L	Arsenic	< 2 μg/L
Potassium	5.7 mg/L	Barium	< 100 μg/L
Alkalinity	641 mg/L	Cadmium	< 1 μg/L
Hydroxide	< 1 mg/L	Chromium	< 10 μg/L
Carbonate	< 2 mg/L	Copper	< 50 μg/L
Bicarbonate	641 mg/L	Iron	606 μg/L
Sulfate	243 mg/L	Lead	<5 μg/L
Chloride	325 mg/L	Manganese	43 μg/L
Nitrate	6 mg/L	Mercury	< 1 μg/L
Flouride	0.33 mg/L	Selenium	< 5 μg/L
pH	6.93	Silver	< 10 μg/L
Specific Conductance	2,400 μmhos/cm	Zinc	< 50 μg/L
Total Dissolved Solids (TDS)	1,542 mg/L	Nickel	23 μg/L

2.2 Pilot Unit Equipment

The pilot unit was designed for a maximum flow of 25 gallons per minute (gpm) and was designed to operate as a three stage RO system. Due to the specific combination of constituents in the feed water and limitations on chemical injection alternatives, the system generally operated at a water recovery less than planned to reduce the potential for precipitation in the third stage. This variation on the original planned recovery is further discussed in Section 4.1.

The overall system included a submersible well pump, cartridge filters, a high pressure pump, 6 pressure vessels, a chemical storage tank, a chemical metering pump, a discharge blending tank and a discharge pump. The pressure vessels were arranged in the three stage system with three 4" x 40" reverse osmosis membranes in each pressure vessel. The permeate and concentrate from the reverse osmosis system both discharged into a tank where they were recombined. This blended water, having nearly the same composition as the feed groundwater, was pumped from the tank into a sprinkler system and used to water an area of adjacent pasture land near the San Benito River. This discharge of water qualified as a low-threat discharge and a permit was obtained for such through the Regional Water Quality Control Board.

The membranes used for the pilot testing were commercial thin film membranes manufactured by Applied Membranes, Inc. Each membrane had an estimated active membrane area of 82 square feet and a maximum permeate flux rate of 15 gallons per day per square foot of membrane area (gpd/sf). The pilot unit operated at a lower flow rate than rated with an observed flux rate between approximately 10.4 and 13.7 gpd/sf.

2.3 Monitoring and Sampling

The pilot unit was equipped with on-line monitoring equipment on the feed, permeate and concentrate piping. Table 2-2 summarizes the monitoring performed on each of the three main flow streams (feed water, permeate, and concentrate).

Table 2-2: Summary of Pilot Unit On-Line Sampling

	Feed Water	Permeate	Concentrate
Total Dissolved Solids	x	x	x
Temperature	x		
Pressure	x	x	x
Flow	x	x	x
pH	x	x	x

On-line instrumentation for measurement of the five areas of interest were connected to a computer that recorded the instantaneous measurements every 15 seconds then averaged these measurements for each minute. This averaged data was recorded and used for data analysis. Hourly averages for the critical parameters throughout the primary testing period are included as Attachment A.

In addition to the on-line instruments, weekly grab samples were taken for laboratory analysis. The laboratory analysis was primarily to identify the levels of dissolved constituents in the various flow streams. The following analytes were evaluated:

- Turbidity
- Alkalinity
- Chloride
- Total dissolved solids (TDS)
- Nitrate
- Sulfate
- Calcium
- Iron
- Magnesium
- Silica
- Sodium
- Dissolved organic carbon

3 Testing Results

Between March 2, 2007 and May 4, 2007 (the primary pilot testing period) approximately 1,285,000 gallons of water was pumped from the brackish groundwater well into the pilot unit. The feed water and the subsequent permeate and concentrate were subjected to the analyses described previously. The following sections summarize the results based on hourly averages of these data.

3.1 Cleaning Periods

Throughout the approximately 2 months of primary pilot testing, the unit required several cleaning operations to maintain the performance of the unit. The major cleaning operations are summarized below.

- March 8, 2007 – 0.01% peroxide cleaning to sanitize the membranes
- March 10, 2007 – acid cleaning using a solution specifically designed for thin film composite RO membranes with mineral scaling
- March 22, 2007 – 0.01% peroxide cleaning, changed prefilters
- March 24, 2007 and March 30, 2007 – Concentrate TDS probe cleaned with sulfuric acid to remove scale and precipitated minerals
- April 6, 2007 – a high velocity flush was used to remove a mineral plug from the concentrate piping
- April 7, 2007 – concentrate and recirculation pipelines cleaned and recirculation flow meter cleaned to remove scaling on probe

- April 11, 2007 and April 12, 2007 – high velocity flush performed to clear system of mineral buildup
- April 12, 2007 – prefilters changed
- April 14, 2007 – high velocity flush
- April 20, 2007 – acid cleaning for membrane scale removal
- April 26, 2007 – cleaned concentrate TDS probed with sulfuric acid

Throughout the pilot testing period, a major complication with the pilot test site was the reliability of the power supply. Periodic power outages caused feed flows to stop, allowing minerals to precipitate from the concentrate in the later process elements.

3.2 Flow Rates & Water Recovery

In any RO treatment system, scaling and fouling over time will tend to reduce the effective membrane area used for filtration. Assuming a constant flux rate per unit surface area for clean membranes, the permeate flow through the membranes will decrease. For the San Benito pilot unit this caused an associated decrease in feed water flow since the unit was generally controlled to achieve a preset feed pressure and a relatively constant concentrate flow, as controlled by a manually adjusted needle valve. For the 13 days and 21 hours between 3:00 pm on April 20, 2007 and 12:00 noon on May 4, 2007 (the longest relatively constant period of operation for the pilot unit), the permeate flow decreased by 1.9 gallons per minute (gpm). This is equivalent to a decrease in membrane flux from 13.1 gpd/sf to 11.3 gpd/sf and a rate of decrease of 0.13 gpm/sf/day. During this same period the system water recovery decreased from 82.53% to 78.51% and the feed pressure increased from 251 psi to 255 psi resulting in change rates of -0.29%/day for water recovery and +0.30 psi/day for feed pressure.

Figure 3-1, Figure 3-2, Figure 3-3 and Figure 3-4 show the various flow rate trends, the permeate flux rate trends, the water recovery/salt rejection trends and the feed pressure trends for the entire pilot testing period. The results indicate that water recoveries increased and salt rejections decreased following cleaning operations. These reactions are manifested in the graphs of the results by the instantaneous changes following process interruptions for cleaning. The decrease in salt rejection may be a function of the removal of some scale or precipitate from the membranes that had previously resulted in a smaller effective membrane opening. Overall the pilot unit achieved a water recovery of approximately 80%. This water recovery was chosen to minimize the potential for mineral precipitation. It should be noted that higher recovery values could likely be achieved with specially designed preliminary chemical injection systems and optimized membrane selection.

Figure 3-1: Flow Rate Trends

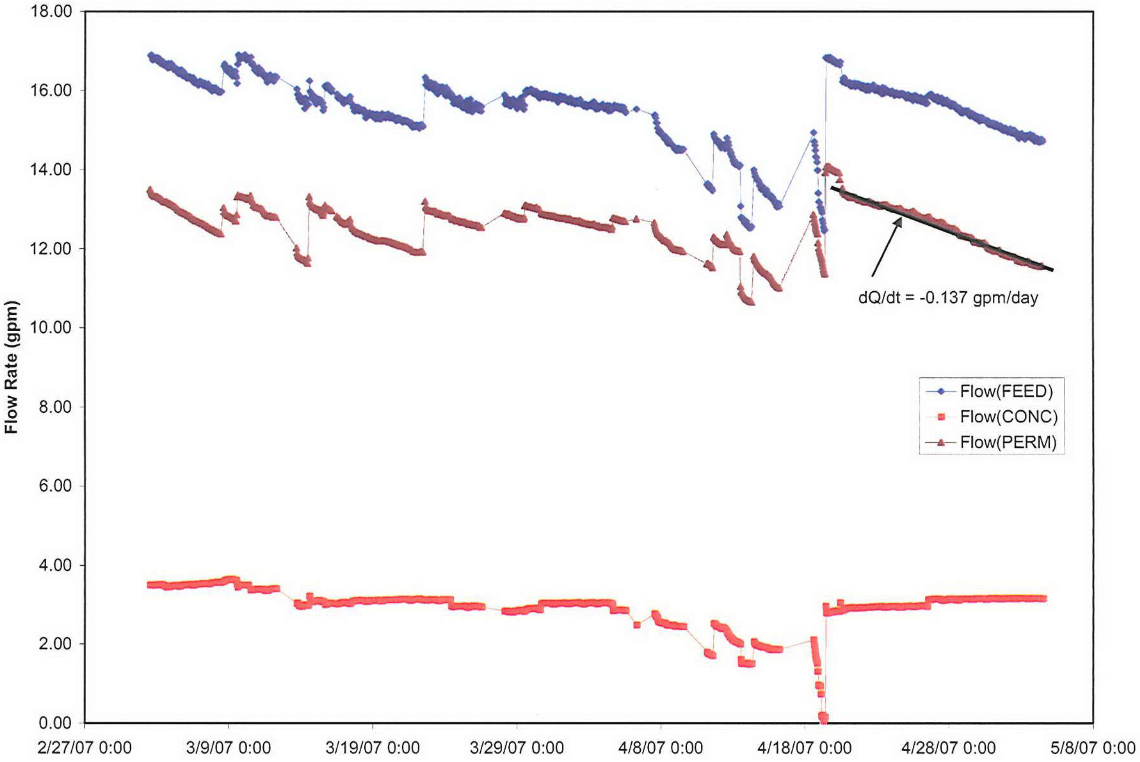


Figure 3-2: Permeate Flux Rate Trends

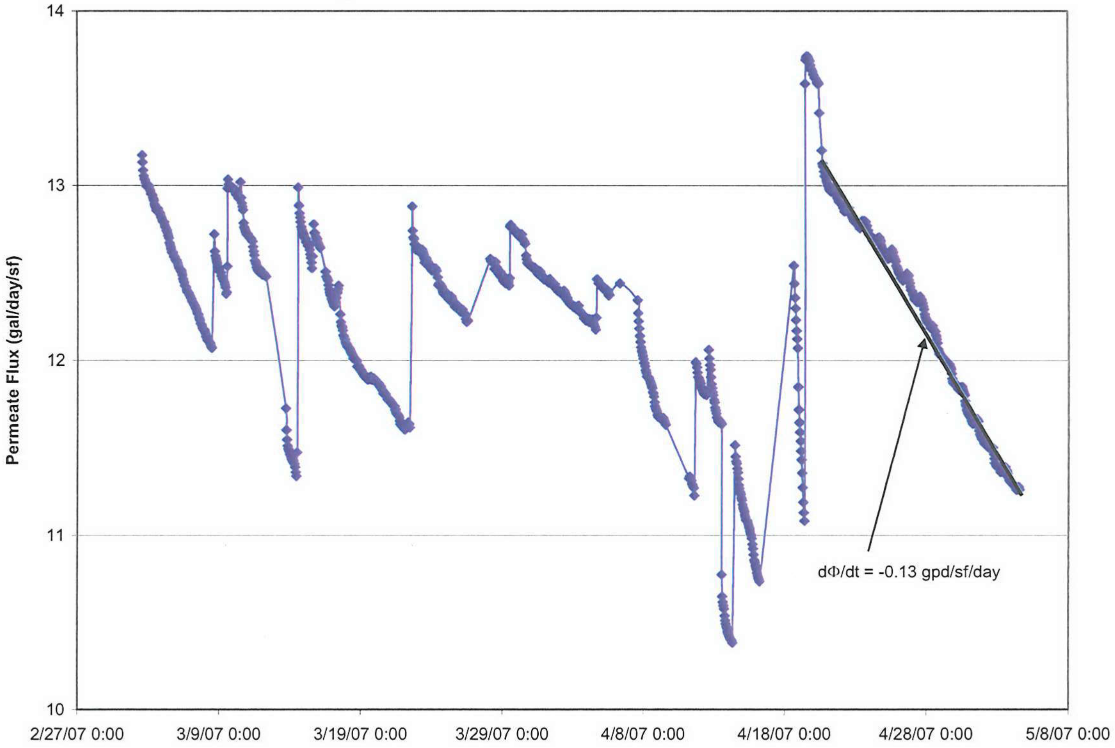
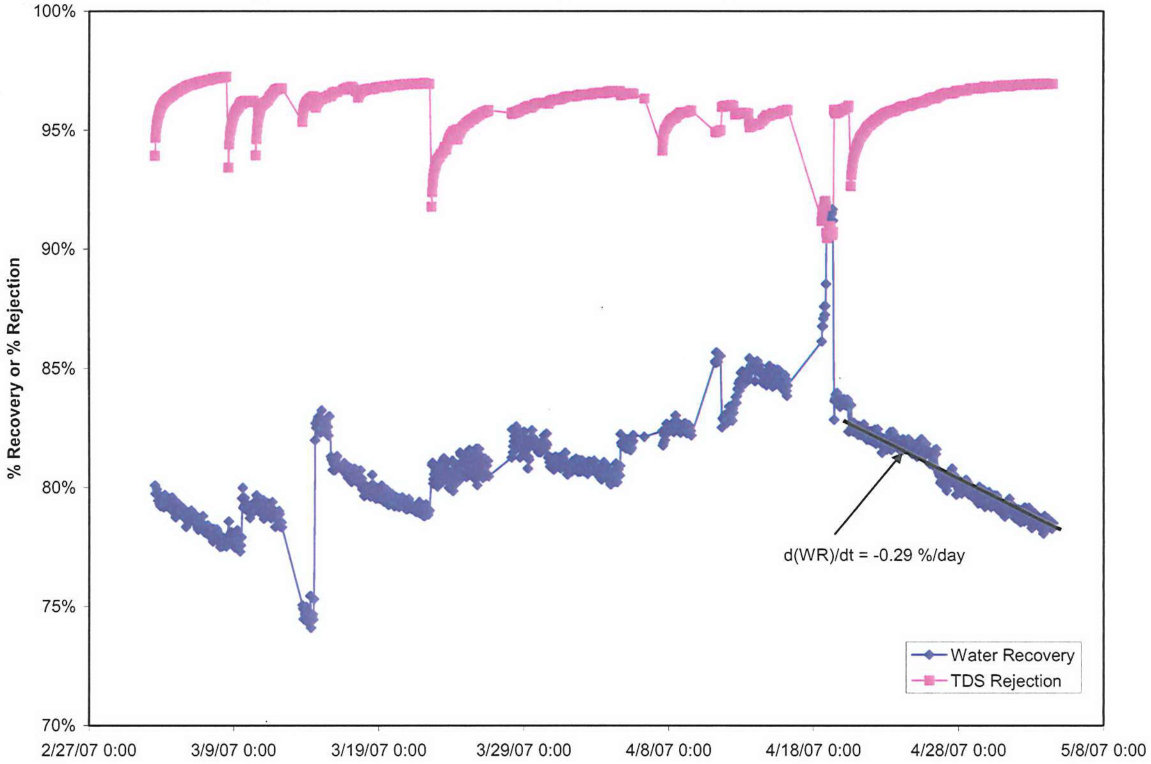
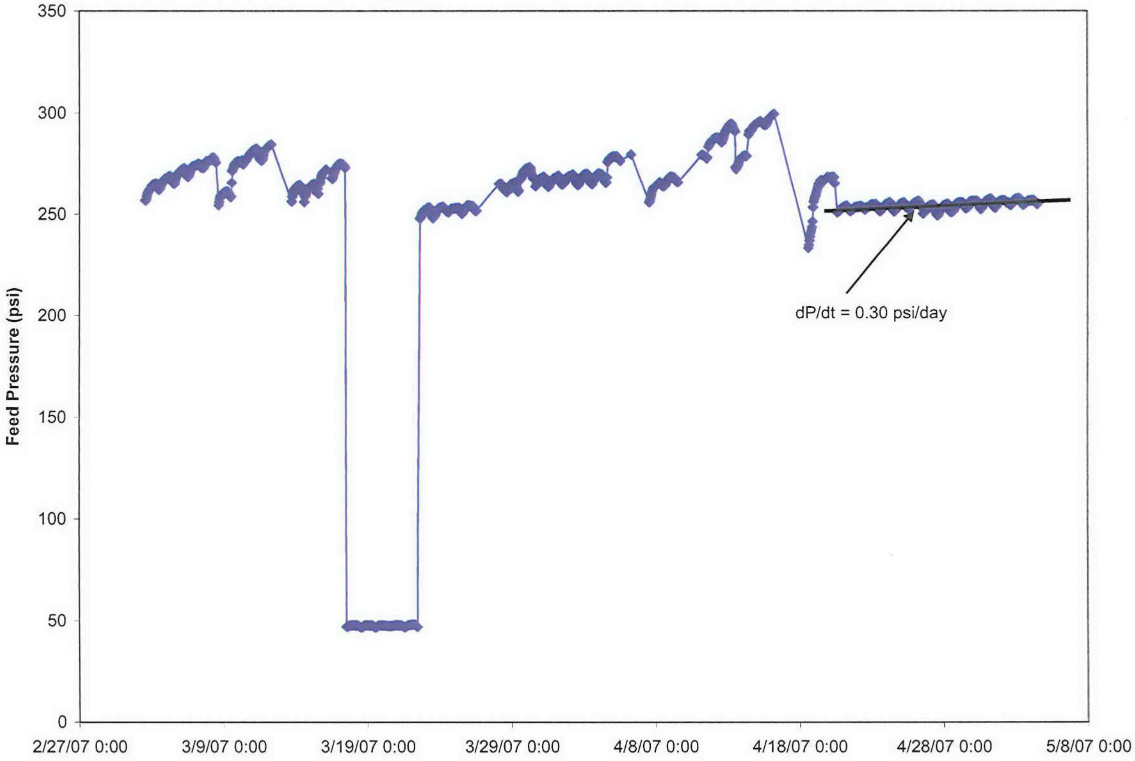


Figure 3-3: Water Recovery and Salt Rejection Trends



One feature of the feed pressure is the diurnal variation seen with peaks occurring near midnight and troughs occurring in the early afternoon each day. The troughs correlate with occurrences of high differential pressure and high concentrate TDS levels. This correlation is further discussed in Section 3.5.

Figure 3-4: Feed Pressure Trends



3.3 TDS Concentrations and Removals

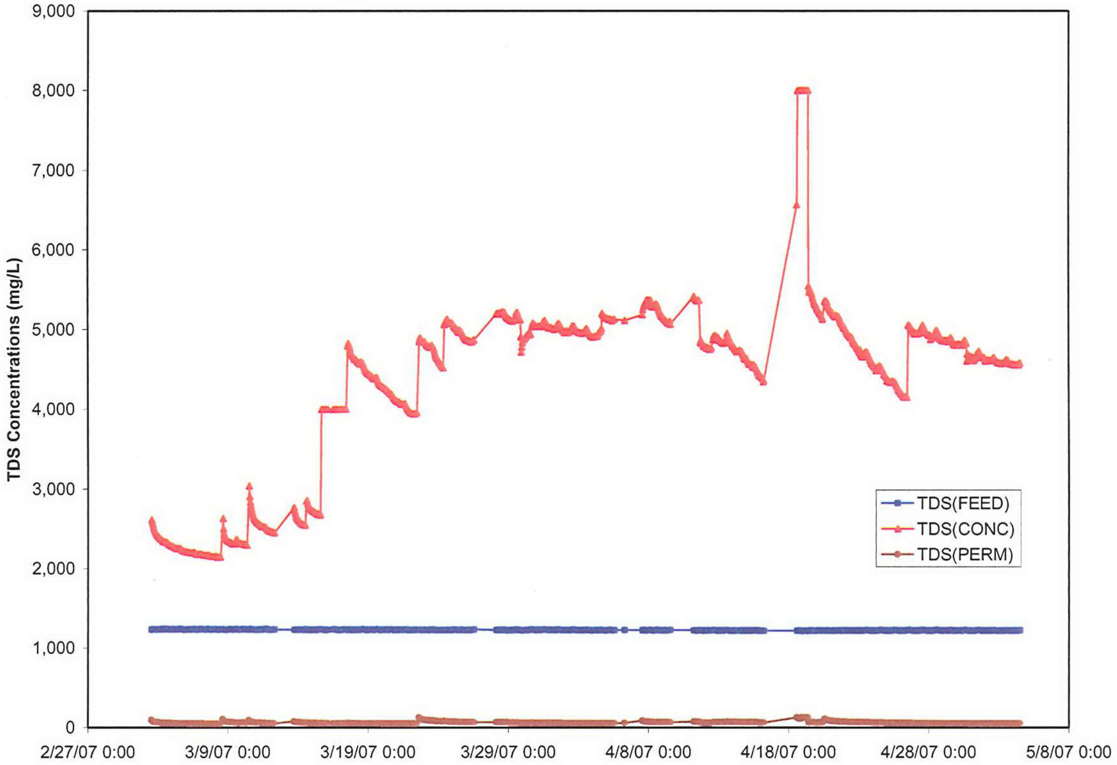
For a scenario where salt removal is critical to achieving the overall water supply and wastewater disposal goals, such as in northern San Benito County, one means of performance evaluation is the concentration of dissolved solids in the various flow streams and the removal of the dissolved solids between the feed water and the permeate.

The feed water to the pilot unit had a relatively constant TDS concentration of approximately 1,225 mg/L and this resulted in a permeate with a similarly constant TDS concentration that averaged approximately 80 mg/L over the entire testing period. Over the final two weeks of testing, the permeate TDS concentration steadily decreased with an average of 55 mg/L and a range from 48 to 80 mg/L. During this time the TDS rejection was approximately 96%.

Figure 3-5 shows the trends in TDS concentrations for the three flow streams as well as the computed TDS rejections over the course of the pilot testing. Some specific dates to note are:

- March 17, 2007 – The concentrate TDS meter was recalibrated to a maximum reading of 8,000 mg/L, increased from 4,000 mg/L previously. This increase was necessary to provide accurate TDS concentration readings for the concentrate.
- April 26, 2007 – The concentrate TDS meter was removed and cleaned with a strong acid solution to remove scale from the probe. This cleaning resulted in significantly more accurate readings.

Figure 3-5: TDS Concentrations Trends



3.4 Water Sampling Results

Water samples were taken from each of the three flow streams (feed water, permeate, and concentrate) seven times during the focused testing period. The seven grab samples were analyzed by the SCVWD water quality laboratory for a set of previously identified parameters. These parameters encompass the range of parameters that typical potable water distribution systems would be interested in for a water supply. The results are summarized in Table 3-1.

It should be noted that the detection limit for iron was 100 µg/L and iron was not detected in any samples despite the iron deposits found on used pre-filters from the site. At the conclusion of the pilot testing period, the cause of this discrepancy was still not determined.

Table 3-1: Water Quality Results for Feed Water, Concentrate, and Permeate

Sample Date		3/5/07	3/19/07	3/27/07	4/3/07	4/9/07	4/24/07	4/30/07
Chloride	Feed	298	304	283	281	293	304	295
	Conc.	999	1370	1460	675	733	1,390	1,310
	Permeate	< 10	10	18	< 10	16	15	12
Alkalinity	Feed	602	584	563	560	574	599	579
	Conc.	3,470	546	2,980	1,370	1,480	2,870	2,640
	Permeate	18	17	25	18	21	21	18
Nitrate	Feed	4.2	4.4	4.1	4.7	4.8	4.7	4.8
	Conc.	19.3	15.7	16.5	17.7	19.6	ND	17.2
	Permeate	ND	0.5	0.5	0.5	ND	ND	ND
Sulfate	Feed	253	250	252	248	251	263	266
	Conc.	1,290	1,060	1,200	1,130	1,270	125	1,150
	Permeate	2.4	2.2	4.1	2.5	3	3.3	2.4
TDS	Feed	1,420	1,410	1,400	1,380	1,390	1,390	1,410
	Conc.	7,490	6,330	6,950	6,300	6,950	6,740	6,170
	Permeate	78	71	90	46	70	66	76
Turbidity	Feed	0.09	0.2	0.16	0.27	0.12	0.08	0.29
	Conc.	0.16	0.07	0.28	0.16	0.12	0.54	4.5
	Permeate	0.1	0.27	0.04	0.04	0.04	0.06	0.09
DOC	Feed	2.9	2.2	2.2	2.5	2.3	2.5	2.5
	Conc.	31	12	8.4	12	14	8.6	15
	Permeate	0.27	ND	ND	ND	ND	ND	ND
Calcium	Feed	105	95.9	104	98.8	92	101	95.7
	Conc.	554	450	499	456	515	516	418
	Permeate	1.3	< 1.0	2.2	1.1	1.3	1.5	0.9
Iron	Feed	ND	ND	ND	ND	ND	ND	ND
	Conc.	ND	ND	ND	ND	ND	ND	ND
	Permeate	ND	ND	ND	ND	ND	ND	ND
Magnesium	Feed	113	108	114	110	95.1	109	102
	Conc.	567	480	518	482	543	538	457
	Permeate	1.4	1.1	2.4	1.3	1.5	1.6	1
Silica	Feed	33.8	30.8	34	32.7	28.9	33	31.5
	Conc.	176	142	162	150	163	166	134
	Permeate	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	1
Sodium	Feed	295	292	301	289	264	318	280
	Conc.	1,700	1,370	1,460	1,330	1,560	1510	1,210
	Permeate	17.6	18.4	25	19.2	21.2	21.4	16.4

Notes

1) All concentrations in mg/L.
2) ND = Non detect
3) ND taken as one half the detection limit for calculations
4) "< x" taken as "x" for calculations

Table 3-1: Water Quality Results for Feed Water, Concentrate, and Permeate

Sample Date		3/5/07	3/19/07	3/27/07	4/3/07	4/9/07	4/24/07	4/30/07
Chloride	Feed	298	304	283	281	293	304	295
	Conc.	999	1370	1460	675	733	1,390	1,310
	Permeate	< 10	10	18	< 10	16	15	12
Alkalinity	Feed	602	584	563	560	574	599	579
	Conc.	3,470	546	2,980	1,370	1,480	2,870	2,640
	Permeate	18	17	25	18	21	21	18
Nitrate	Feed	4.2	4.4	4.1	4.7	4.8	4.7	4.8
	Conc.	19.3	15.7	16.5	17.7	19.6	ND	17.2
	Permeate	ND	0.5	0.5	0.5	ND	ND	ND
Sulfate	Feed	253	250	252	248	251	263	266
	Conc.	1,290	1,060	1,200	1,130	1,270	125	1,150
	Permeate	2.4	2.2	4.1	2.5	3	3.3	2.4
TDS	Feed	1,420	1,410	1,400	1,380	1,390	1,390	1,410
	Conc.	7,490	6,330	6,950	6,300	6,950	6,740	6,170
	Permeate	78	71	90	46	70	66	76
Turbidity	Feed	0.09	0.2	0.16	0.27	0.12	0.08	0.29
	Conc.	0.16	0.07	0.28	0.16	0.12	0.54	4.5
	Permeate	0.1	0.27	0.04	0.04	0.04	0.06	0.09
DOC	Feed	2.9	2.2	2.2	2.5	2.3	2.5	2.5
	Conc.	31	12	8.4	12	14	8.6	15
	Permeate	0.27	ND	ND	ND	ND	ND	ND
Calcium	Feed	105	95.9	104	98.8	92	101	95.7
	Conc.	554	450	499	456	515	516	418
	Permeate	1.3	< 1.0	2.2	1.1	1.3	1.5	0.9
Iron	Feed	ND	ND	ND	ND	ND	ND	ND
	Conc.	ND	ND	ND	ND	ND	ND	ND
	Permeate	ND	ND	ND	ND	ND	ND	ND
Magnesium	Feed	113	108	114	110	95.1	109	102
	Conc.	567	480	518	482	543	538	457
	Permeate	1.4	1.1	2.4	1.3	1.5	1.6	1
Silica	Feed	33.8	30.8	34	32.7	28.9	33	31.5
	Conc.	176	142	162	150	163	166	134
	Permeate	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	< 2.0	1
Sodium	Feed	295	292	301	289	264	318	280
	Conc.	1,700	1,370	1,460	1,330	1,560	1510	1,210
	Permeate	17.6	18.4	25	19.2	21.2	21.4	16.4

Notes
1) All concentrations in mg/L.
2) ND = Non detect
3) ND taken as one half the detection limit for calculations
4) "< x" taken as "x" for calculations

To analyze the improvement in the water quality as a result of the reverse osmosis process, the percent of mass removed from the feed stream was calculated for all but two of the analytes. Turbidity and iron were not analyzed using this method since turbidity is not necessarily a conservative parameter and iron was not detected in any of the samples. Alkalinity is also a non-conservative parameter, however, the change in alkalinity between the feed water and the permeate is anticipated to be roughly similar for a full-scale reverse osmosis system operating on a similar source water. The concentration factor, the ratio of the concentration of each specific parameter in the concentrate to the concentration in the feed water, for each of these parameters was also calculated to provide insight on the potential composition of the concentrate stream. Both the percent removal and concentration factor values are specific to the actual membrane used in the reverse osmosis process so the values observed in a full-scale installation may vary from the pilot unit observations. Table 3-2 summarizes the averaged values for percent removal and concentration factor for 10 of the parameters analyzed.

Table 3-2: Specific Parameter Removals and Concentration Factors

Parameter	% Removal	Concentration Factor
Chloride	96%	3.8
Alkalinity	97%	3.8
Nitrate	96%	3.9
Sulfate	99%	4.1
TDS	96%	4.8
DOC	99%	5.8
Calcium	99%	4.9
Magnesium	99%	4.8
Silica	95%	4.9
Sodium	95%	5.0

From these results, the reverse osmosis process performed very well in removing large percentage of these identified constituents and produced a waste concentrate that had relatively high concentrations of dissolved constituents.

3.5 RO Feed Pressure

One measure of the degree of blockage of the reverse osmosis membranes is the required feed pressure for the RO system. The feed water side of the membrane is the high pressure side and this high pressure allows the water to be forced through the membrane while preventing the dissolved solids from passing through. The permeate side of the membrane typically operated at a pressure very close to atmospheric pressure (0 psig) while the feed water side operated at 250 to 300 psig. As the membrane becomes fouled or scaled, the pressure required to maintain the same flow through the membrane must increase and the differential pressure is a good tool to evaluate this temporal change. The ability to return the feed pressures to near 250 psi after cleaning operations indicates that this unit did not experience significant irreversible fouling from this feed water. On a daily basis, the lowest feed pressures typically occurred in the early afternoon corresponding to the daily peaks in concentrate TDS concentration. This may be indicative of some temperature impacts on the RO process during the hottest portions of the day. The temperature variations may be a result of the small length of pipe that was exposed to sunlight outside of the canopy enclosing the pilot unit. Typical daily temperature increases were less than 5 degrees Fahrenheit which corresponded to feed pressure decreases of approximately 4 psi. This decrease in feed pressure is a result of the reduction in water density at increased temperatures. The lower density water is more easily passed through the RO membrane resulting in a decreased feed pressure requirement and an increased removal of fresh water from the feed flow, resulting in higher TDS levels in the concentrate flow.

4 Operations and Maintenance Lessons

The operation of the pilot reverse osmosis system provided some insight into potential operational scenarios that could be encountered in the operation of a full-scale facility. Some of these scenarios are discussed below.

4.1 Power Failures

A major operational challenge at the pilot test location was the low reliability of the power supply. On a relatively regular basis a power failure would occur at the site. During the initial operation of the pilot system these events would cause all pumps to shut down and the flow through the pressure vessels would stop. While this did not impact the first two stages of the RO system, in the third-stage RO membrane the concentration of several compounds in the concentrate side was such that they were above their saturation levels. With the loss of motion in the fluid stream, the oversaturation of these compounds allowed precipitation onto the membrane surfaces. This precipitation resulted in extreme fouling that required acid cleaning to remove.

After the acid cleaning, the membranes showed nearly 100% recovery in flux rates. Peroxide cleanings resulted in similar flux rate recoveries and high velocity flushing provided an incremental recovery of the flux rates, but not as significant as acid or peroxide cleanings. The acid and peroxide cleanings were labor intensive for the pilot system and results in a relatively large quantity of waste cleaning solution that required disposal. A full scale system would likely have an automated cleaning system. However, disposal of the waste cleaning solution would still be required.

To allow for continual testing without the need for frequent cleaning, a groundwater flushing system was installed with an uninterruptible power supply (UPS). This system activated when power was lost to fill each pressure vessel with raw groundwater, thereby flushing the concentrated fluid from the system and preventing mineral precipitation onto the membranes.

In a full scale demineralization facility, the frequent power failures are anticipated to be managed through one or more of the following methods:

- Ensure that the power supply and associated infrastructure from PG&E (the local electric utility) is adequate for the power demands of the demineralization facility
- Provide a flushing system to fill the demineralization process with permeate, blended product water or raw groundwater in the event of a system shut down
- Include a standby generator in the design to allow for mitigation of power outages. The mitigation could range from short-term operation to flush the system to longer term operation of the complete facility

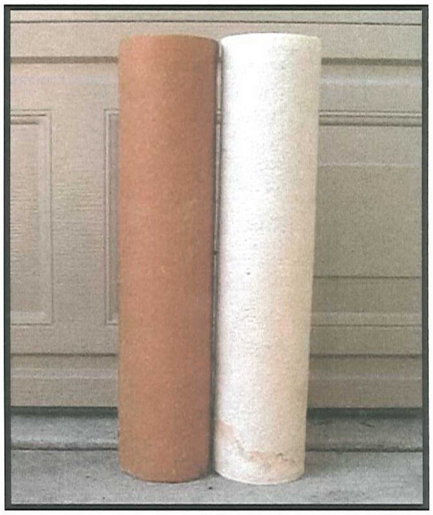
4.2 Instrument Cleaning

Instrument probes in the concentrate fluid stream were observed to be prone to scaling and precipitation, thereby compromising the accuracy of the readings. These probes required periodic cleaning using high strength acid solutions to remove the scaling and allow for proper operation and data collection. This cleaning was operator-intensive and required that the unit be taken off-line during the cleaning. In a full-scale system and where possible, instruments should be installed in locations where isolation valves could be closed or a bypass loop enabled to allow operation of the treatment system during cleaning.

4.3 Preliminary Cartridge Filters

The cartridge filters installed upstream of the high pressure pump appeared to be relatively successful at preventing large particles from entering the reverse osmosis pressure vessels as there was no evidence of plugging or damage as a result of large particles. The filters did appear to remove iron from the feed water, even though sampling and analysis did not indicate any significant iron in the feed water. Figure 4-1 shows one pre-filter from the San Benito site (on the left) next to one pre-filter from pilot testing at a different site (on the right). The reddish color to the San Benito pre-filter qualitatively indicates that there is iron in the feed water that is being removed by the pre-filter. Additional laboratory analysis on the prefilters indicated that several metals and other constituents were present. The main constituents quantified on the pre-filters were calcium, iron, magnesium, sodium and zinc, with iron having the largest mass reported from the analysis. Based on these results, it is recommended that prior to design of the pretreatment portion of a full-scale facility, detailed testing for metals and their states (e.g. ferric versus ferrous) should be performed to determine the potential for metal capture.

Figure 4-1: Comparison of Used Pre-Filters from San Benito (Left) and Second Stanford Pilot Site (Right)



5 Conclusions

Based on the results of the pilot testing, demineralization of groundwater from the San Juan Valley is feasible. A specific evaluation of the source water will be required to determine the optimal membrane and preliminary chemical dosing required to maximize the water recovery and energy efficiency of a full-scale reverse osmosis system. The cleaning required to manage the scaling, mineral precipitation and fouling in the later stages of RO system will be a critical design criteria and inclusion of provisions to minimize its frequency and simplify its execution will be very important to the final operation of the facility. An evaluation of the specific water recovery that is possible through an RO unit will also need to be determined through specific pilot testing at an identified source well with specific membranes evaluated for use in the full scale project. The pilot unit used for this testing should be configured as close as possible to the full-scale facility in terms of the number of membranes in each pressure vessel, the number of stages, the ratio of pressure vessels in each stage and the use of concentrate recirculation. Information from this "proof" pilot testing should be incorporated into the final design of the facility to correlate actual operation with the design of the facility.

Attachment A – Hourly Pilot Testing Results

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/3/07 13:00	16.88	3.50	13.50	7.6	7.9	6.4	1,232	2,615	93	257	0	0	0.0	80%	94%
3/3/07 14:00	16.90	3.50	13.46	7.6	7.9	6.3	1,237	2,586	83	256	0	0	0.0	80%	95%
3/3/07 15:00	16.84	3.50	13.41	7.6	7.9	6.3	1,238	2,557	77	257	0	0	0.0	80%	95%
3/3/07 16:00	16.76	3.50	13.38	7.6	7.9	6.3	1,235	2,525	73	259	0	0	0.0	80%	95%
3/3/07 17:00	16.78	3.50	13.36	7.6	7.9	6.3	1,234	2,500	71	260	0	0	0.0	80%	95%
3/3/07 18:00	16.82	3.49	13.36	7.6	7.9	6.2	1,233	2,481	69	261	0	0	0.0	79%	96%
3/3/07 19:00	16.81	3.50	13.34	7.6	7.9	6.2	1,233	2,463	68	261	0	0	0.0	79%	96%
3/3/07 20:00	16.82	3.50	13.32	7.6	7.9	6.2	1,233	2,447	66	262	0	0	0.0	79%	96%
3/3/07 21:00	16.80	3.50	13.33	7.6	7.9	6.2	1,233	2,435	65	263	0	0	0.0	79%	96%
3/3/07 22:00	16.83	3.50	13.32	7.6	7.9	6.2	1,233	2,423	64	263	0	0	0.0	79%	96%
3/3/07 23:00	16.75	3.50	13.32	7.6	7.9	6.2	1,233	2,414	63	263	0	0	0.0	80%	96%
3/4/07 0:00	16.79	3.51	13.33	7.6	7.9	6.2	1,233	2,405	62	264	0	0	0.0	79%	96%
3/4/07 1:00	16.82	3.51	13.32	7.6	7.9	6.2	1,234	2,397	61	264	0	0	0.0	79%	96%
3/4/07 2:00	16.78	3.51	13.30	7.6	7.9	6.2	1,234	2,389	61	265	0	0	0.0	79%	96%
3/4/07 3:00	16.80	3.51	13.29	7.6	7.9	6.2	1,235	2,380	60	265	0	0	0.0	79%	96%
3/4/07 4:00	16.73	3.51	13.28	7.6	7.9	6.2	1,236	2,374	60	265	0	0	0.0	79%	96%
3/4/07 5:00	16.68	3.51	13.28	7.6	7.9	6.2	1,236	2,369	59	265	0	0	0.0	80%	96%
3/4/07 6:00	16.75	3.52	13.27	7.6	7.9	6.2	1,237	2,363	59	265	0	0	0.0	79%	96%
3/4/07 7:00	16.73	3.52	13.25	7.6	7.9	6.2	1,237	2,356	58	265	0	0	0.0	79%	96%
3/4/07 8:00	16.73	3.51	13.25	7.6	7.9	6.2	1,234	2,343	58	265	0	0	0.0	79%	96%
3/4/07 9:00	16.73	3.50	13.24	7.6	7.9	6.2	1,233	2,339	58	264	0	0	0.0	79%	96%
3/4/07 10:00	16.64	3.49	13.22	7.6	7.9	6.1	1,236	2,341	57	263	0	0	0.0	80%	96%
3/4/07 11:00	16.67	3.49	13.20	7.6	7.9	6.1	1,237	2,339	57	262	0	0	0.0	79%	96%
3/4/07 12:00	16.63	3.48	13.19	7.6	7.9	6.1	1,238	2,337	57	262	0	0	0.0	79%	96%
3/4/07 13:00	16.63	3.48	13.18	7.6	7.9	6.1	1,241	2,337	57	262	0	0	0.0	79%	96%
3/4/07 14:00	16.62	3.48	13.18	7.6	7.9	6.1	1,242	2,332	56	263	0	0	0.0	79%	96%
3/4/07 15:00	16.62	3.45	13.18	7.6	7.9	6.1	1,239	2,329	56	264	0	0	0.0	79%	96%
3/4/07 16:00	16.65	3.44	13.19	7.6	7.9	6.1	1,237	2,323	56	265	0	0	0.0	79%	96%
3/4/07 17:00	16.57	3.45	13.17	7.6	7.9	6.1	1,236	2,314	55	265	0	0	0.0	80%	96%
3/4/07 18:00	16.68	3.45	13.16	7.6	8.0	6.1	1,234	2,308	55	266	0	0	0.0	79%	96%
3/4/07 19:00	16.57	3.45	13.16	7.6	8.0	6.1	1,234	2,302	55	267	0	0	0.0	80%	96%
3/4/07 20:00	16.64	3.45	13.15	7.6	8.0	6.1	1,234	2,298	54	267	0	0	0.0	79%	97%
3/4/07 21:00	16.60	3.45	13.14	7.6	7.9	6.1	1,234	2,293	54	267	0	0	0.0	79%	97%
3/4/07 22:00	16.62	3.46	13.14	7.6	8.0	6.1	1,233	2,287	54	268	0	0	0.0	79%	97%
3/4/07 23:00	16.68	3.47	13.12	7.6	7.9	6.1	1,234	2,283	54	268	0	0	0.0	79%	97%
3/5/07 0:00	16.60	3.47	13.11	7.6	7.9	6.1	1,235	2,282	53	268	0	0	0.0	79%	97%
3/5/07 1:00	16.65	3.47	13.11	7.6	7.9	6.1	1,237	2,281	53	268	0	0	0.0	79%	97%
3/5/07 2:00	16.58	3.48	13.11	7.6	7.9	6.1	1,237	2,278	53	268	0	0	0.0	79%	97%
3/5/07 3:00	16.53	3.48	13.09	7.6	7.9	6.1	1,237	2,275	53	268	0	0	0.0	79%	97%
3/5/07 4:00	16.53	3.48	13.08	7.6	7.9	6.1	1,233	2,265	52	269	0	0	0.0	79%	97%
3/5/07 5:00	16.55	3.49	13.08	7.6	7.9	6.1	1,234	2,263	52	269	0	0	0.0	79%	97%
3/5/07 6:00	16.53	3.49	13.06	7.6	7.9	6.1	1,235	2,262	52	269	0	0	0.0	79%	97%
3/5/07 7:00	16.55	3.49	13.06	7.6	7.9	6.1	1,234	2,257	52	269	0	0	0.0	79%	97%
3/5/07 8:00	16.50	3.48	13.05	7.6	7.9	6.1	1,233	2,252	51	268	0	0	0.0	79%	97%
3/5/07 9:00	16.53	3.48	13.03	7.6	7.9	6.1	1,234	2,252	51	267	0	0	0.0	79%	97%
3/5/07 10:00	16.47	3.47	13.01	7.6	7.9	6.1	1,236	2,254	51	266	0	0	0.0	79%	97%
3/5/07 11:00	16.43	3.47	12.99	7.6	7.9	6.1	1,238	2,256	51	266	0	0	0.0	79%	97%
3/5/07 12:00	16.43	3.46	12.98	7.6	7.9	6.1	1,239	2,255	51	265	0	0	0.0	79%	97%
3/5/07 13:00	16.44	3.46	12.97	7.6	7.9	6.1	1,240	2,255	51	265	0	0	0.0	79%	97%
3/5/07 14:00	16.47	3.46	12.95	7.6	7.9	6.1	1,241	2,253	50	265	0	0	0.0	79%	97%
3/5/07 15:00	16.43	3.47	12.93	7.6	7.9	6.1	1,240	2,249	50	266	0	0	0.0	79%	97%
3/5/07 16:00	16.52	3.48	12.93	7.6	7.9	6.1	1,236	2,238	50	268	0	0	0.0	78%	97%
3/5/07 17:00	16.43	3.49	12.93	7.6	7.9	6.1	1,234	2,232	49	269	0	0	0.0	79%	97%
3/5/07 18:00	16.37	3.50	12.91	7.6	8.0	6.1	1,233	2,227	49	269	0	0	0.0	79%	97%
3/5/07 19:00	16.37	3.50	12.91	7.6	8.0	6.1	1,233	2,223	49	270	0	0	0.0	79%	97%
3/5/07 20:00	16.46	3.50	12.91	7.6	7.9	6.1	1,233	2,221	49	270	0	0	0.0	79%	97%
3/5/07 21:00	16.36	3.50	12.89	7.6	7.9	6.1	1,233	2,218	49	271	0	0	0.0	79%	97%
3/5/07 22:00	16.35	3.50	12.88	7.6	7.9	6.1	1,233	2,215	49	271	0	0	0.0	79%	97%
3/5/07 23:00	16.37	3.51	12.89	7.6	7.9	6.1	1,233	2,213	49	271	0	0	0.0	79%	97%
3/6/07 0:00	16.37	3.51	12.87	7.6	7.9	6.1	1,233	2,211	48	272	0	0	0.0	79%	97%
3/6/07 1:00	16.30	3.51	12.87	7.6	7.9	6.1	1,233	2,210	48	272	0	0	0.0	79%	97%
3/6/07 2:00	16.33	3.51	12.86	7.6	7.9	6.1	1,234	2,210	48	272	0	0	0.0	79%	97%
3/6/07 3:00	16.35	3.51	12.84	7.6	7.9	6.1	1,233	2,206	48	272	0	0	0.0	79%	97%
3/6/07 4:00	16.34	3.51	12.84	7.6	7.9	6.1	1,233	2,204	48	272	0	0	0.0	79%	97%
3/6/07 5:00	16.33	3.51	12.84	7.6	7.9	6.1	1,234	2,204	48	273	0	0	0.0	79%	97%
3/6/07 6:00	16.34	3.51	12.82	7.6	7.9	6.1	1,234	2,203	48	273	0	0	0.0	79%	97%
3/6/07 7:00	16.31	3.52	12.83	7.6	7.9	6.1	1,234	2,201	48	272	0	0	0.0	79%	97%
3/6/07 8:00	16.31	3.51	12.81	7.6	7.9	6.1	1,232	2,197	48	271	0	0	0.0	79%	97%
3/6/07 9:00	16.25	3.50	12.80	7.6	7.9	6.1	1,233	2,198	48	270	0	0	0.0	79%	97%
3/6/07 10:00	16.28	3.50	12.78	7.6	7.9	6.1	1,235	2,200	48	269	0	0	0.0	79%	97%
3/6/07 11:00	16.31	3.50	12.76	7.6	7.9	6.0	1,237	2,202	48	269	0	0	0.0	78%	97%
3/6/07 12:00	16.32	3.49	12.75	7.6	7.9	6.0	1,239	2,204	47	268	0	0	0.0	78%	97%
3/6/07 13:00	16.20	3.49	12.74	7.6	7.9	6.0	1,240	2,206	47	268	0	0	0.0	79%	97%
3/6/07 14:00	16.26	3.50	12.73	7.6	7.9	6.1	1,239	2,201	47	269	0	0	0.0	78%	97%
3/6/07 15:00	16.21	3.50	12.73	7.6	7.9	6.1	1,237	2,195	47	270	0	0	0.0	79%	97%
3/6/07 16:00	16.20	3.51	12.71	7.6	7.9	6.1	1,235	2,191	47	271	0	0	0.0	79%	97%
3/6/07 17:00	16.20	3.52	12.70	7.6	7.9	6.1	1,233	2,185	47	272	0	0	0.0	79%	97%
3/6/07 18:00	16.21	3.52	12.70	7.6	7.9	6.1	1,232	2,181	46	273	0	0	0.0	78%	97%
3/6/07 19:00	16.19	3.52	12.70	7.6	7.9	6.1	1,232	2,179	46	273	0	0	0.0	79%	97%
3/6/07 20:00	16.12	3.52	12.69	7.6	7.9	6.1	1,233	2,180	46	273	0	0	0.0	79%	97%
3/6/07 21:00	16.21	3.52	12.68	7.6	7.9	6.1	1,235	2,181	46	274	0	0	0.0	78%	97%
3/6/07 22:00	16.18	3.52	12.67	7.6	7.9	6.1	1,236	2,182	46	274	0	0	0.0	78%	97%
3/6/07 23:00	16.23	3.52	12.67	7.6	7.9	6.1	1,236	2,182	46	274	0	0	0.0	78%	97%
3/7/07 0:00	16.20	3.53	12.66	7.6	7.9	6.1	1,237	2,182	46	274	0	0	0.0	78%	97%
3/7/07 1:00	16.18	3.53	12.65	7.6	7.9	6.1	1,237	2,181	46	274	0	0	0.0	78%	97%
3/7/07 2:00	16.18	3.53	12.64	7.6	7.9	6.1	1,238	2,181	46	274	0	0	0.0	78%	97%
3/7/07 3:00	16.21	3.54	12.64	7.6	7.9	6.1	1,238	2,179	46	274	0	0	0.0	78%	97%
3/7/07 4:00	16.12	3.54	12.63	7.7	7.9	6.1	1,237	2,176	46	275	0	0	0.0	78%	97%
3/7/07 5:00	16.18	3.54	12.62	7.7	7.9	6.1	1,234	2,169	46	275	0	0	0.0	78%	97%
3/7/07 6:00	16.13	3.54	12.62	7.7	7.9	6.1	1,234	2,169	46	275	0	0	0.0	78%	97%
3/7/07 7:00	16.18	3.54	12.61	7.7	7.9	6.1	1,235	2,170	46	275	0	0	0.0	78%	97%
3/7/07 8:00	16.11	3.53	12.60	7.6	7.9	6.0	1,235	2,168	46	275	0	0	0.0	78%	97%
3/7/07 9:00	16.14	3.53	12.59	7.6	7.9	6.0	1,233	2,164	46	274	0	0	0.0	78%	97%
3/7/07 10:00	16.11	3.53	12.58	7.6	7.9	6.0	1,234	2,166	45	273	0	0	0.0	78%	97%
3/7/07 11:00	16.13	3.53	12.57	7.6	7.9	6.0	1,236	2,171	45	273	0	0	0.0	78%	97%
3/7/07 12:00	16.14	3.53	12.57	7.6	7.9	6.0	1,237	2,170	45	273	0	0	0.0	78%	97%
3/7/07 13:00	16.16	3.53	12.55	7.6	7.9	6.0	1,237	2,168	45	273	0	0	0.0	78%	97%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/7/07 14:00	16.05	3.53	12.54	7.6	7.9	6.0	1,238	2,169	45	273	0	0	0.0	78%	97%
3/7/07 15:00	16.08	3.53	12.53	7.6	7.9	6.0	1,239	2,169	45	274	0	0	0.0	78%	97%
3/7/07 16:00	16.02	3.54	12.52	7.6	7.9	6.0	1,234	2,161	45	275	0	0	0.0	78%	97%
3/7/07 17:00	16.08	3.54	12.51	7.6	7.9	6.0	1,233	2,157	45	275	0	0	0.0	78%	97%
3/7/07 18:00	16.01	3.55	12.50	7.7	7.9	6.0	1,232	2,154	45	276	0	0	0.0	78%	97%
3/7/07 19:00	15.97	3.56	12.49	7.7	7.9	6.0	1,232	2,151	45	276	0	0	0.0	78%	97%
3/7/07 20:00	15.99	3.56	12.48	7.7	7.9	6.0	1,234	2,153	45	276	0	0	0.0	78%	97%
3/7/07 21:00	16.06	3.56	12.48	7.7	7.9	6.0	1,235	2,154	45	276	0	0	0.0	78%	97%
3/7/07 22:00	16.06	3.56	12.48	7.6	7.9	6.0	1,234	2,153	44	276	0	0	0.0	78%	97%
3/7/07 23:00	16.01	3.56	12.47	7.6	7.9	6.0	1,235	2,153	44	276	0	0	0.0	78%	97%
3/8/07 0:00	16.00	3.56	12.46	7.6	7.9	6.0	1,235	2,153	44	276	0	0	0.0	78%	97%
3/8/07 1:00	16.06	3.56	12.44	7.6	7.9	6.0	1,236	2,153	44	276	0	0	0.0	78%	97%
3/8/07 2:00	16.04	3.56	12.44	7.7	7.9	6.0	1,237	2,154	44	277	0	0	0.0	78%	97%
3/8/07 3:00	16.00	3.57	12.42	7.7	7.9	6.0	1,237	2,154	44	277	0	0	0.0	78%	97%
3/8/07 4:00	16.03	3.57	12.41	7.7	7.9	6.0	1,233	2,147	44	278	0	0	0.0	78%	97%
3/8/07 5:00	15.96	3.57	12.41	7.7	7.9	6.0	1,232	2,143	44	278	0	0	0.0	78%	97%
3/8/07 6:00	15.98	3.57	12.41	7.7	7.9	6.0	1,234	2,146	44	278	0	0	0.0	78%	97%
3/8/07 7:00	15.94	3.57	12.40	7.7	7.9	6.0	1,235	2,147	44	278	0	0	0.0	78%	97%
3/8/07 8:00	15.98	3.57	12.40	7.6	7.9	6.0	1,233	2,143	44	277	0	0	0.0	78%	97%
3/8/07 9:00	15.95	3.57	12.39	7.6	7.9	6.0	1,233	2,142	44	276	0	0	0.0	78%	97%
3/8/07 10:00	15.95	3.57	12.38	7.6	7.9	6.0	1,234	2,145	44	276	0	0	0.0	78%	97%
3/8/07 11:00	15.97	3.56	12.37	7.6	7.9	6.0	1,236	2,149	44	275	0	0	0.0	78%	97%
3/8/07 15:00	16.61	3.59	13.04	7.6	7.9	6.4	1,236	2,630	103	254	0	0	0.0	79%	93%
3/8/07 16:00	16.67	3.60	12.94	7.6	7.9	6.4	1,235	2,500	89	256	0	0	0.0	78%	94%
3/8/07 17:00	16.58	3.62	12.91	7.7	7.9	6.3	1,233	2,444	83	257	0	0	0.0	78%	95%
3/8/07 18:00	16.54	3.62	12.90	7.7	7.9	6.3	1,232	2,413	79	258	0	0	0.0	78%	95%
3/8/07 19:00	16.51	3.63	12.88	7.7	7.9	6.3	1,232	2,393	77	259	0	0	0.0	78%	95%
3/8/07 20:00	16.52	3.64	12.87	7.7	7.9	6.3	1,232	2,379	75	259	0	0	0.0	78%	95%
3/8/07 21:00	16.55	3.64	12.85	7.7	7.9	6.3	1,232	2,367	73	260	0	0	0.0	78%	95%
3/8/07 22:00	16.51	3.64	12.84	7.7	7.9	6.3	1,232	2,358	71	260	0	0	0.0	78%	95%
3/8/07 23:00	16.45	3.64	12.83	7.7	7.9	6.3	1,233	2,350	70	260	0	0	0.0	78%	96%
3/9/07 0:00	16.49	3.64	12.82	7.7	7.9	6.2	1,233	2,344	69	261	0	0	0.0	78%	96%
3/9/07 1:00	16.56	3.64	12.82	7.7	7.9	6.2	1,233	2,340	68	261	0	0	0.0	77%	96%
3/9/07 2:00	16.47	3.64	12.81	7.7	7.9	6.2	1,235	2,337	67	261	0	0	0.0	78%	96%
3/9/07 3:00	16.47	3.64	12.79	7.7	7.9	6.2	1,236	2,334	67	261	0	0	0.0	78%	96%
3/9/07 4:00	16.44	3.64	12.79	7.7	7.9	6.2	1,236	2,329	66	261	0	0	0.0	78%	96%
3/9/07 5:00	16.36	3.64	12.78	7.7	7.9	6.2	1,235	2,325	65	261	0	0	0.0	78%	96%
3/9/07 6:00	16.39	3.64	12.77	7.7	7.9	6.2	1,235	2,321	65	261	0	0	0.0	78%	96%
3/9/07 7:00	16.41	3.64	12.77	7.7	7.9	6.2	1,233	2,315	64	261	0	0	0.0	78%	96%
3/9/07 8:00	16.45	3.64	12.76	7.7	7.9	6.2	1,232	2,309	63	260	0	0	0.0	78%	96%
3/9/07 9:00	16.44	3.63	12.74	7.7	7.9	6.2	1,232	2,310	63	260	0	0	0.0	78%	96%
3/9/07 10:00	16.48	3.63	12.73	7.6	7.9	6.2	1,233	2,309	62	259	0	0	0.0	77%	96%
3/9/07 11:00	16.37	3.62	12.69	7.6	7.9	6.2	1,235	2,311	61	258	0	0	0.0	78%	96%
3/9/07 12:00	16.32	3.62	12.70	7.6	7.9	6.2	1,236	2,312	61	258	0	0	0.0	78%	96%
3/9/07 13:00	16.17	3.54	12.85	7.6	7.9	6.1	1,237	2,323	61	265	0	0	0.0	80%	96%
3/9/07 14:00	16.66	3.44	13.31	7.6	7.9	6.1	1,236	2,373	60	271	0	0	0.0	80%	96%
3/9/07 15:00	16.89	3.48	13.36	7.7	7.9	6.2	1,237	2,365	60	272	0	0	0.0	79%	96%
3/9/07 16:00	16.85	3.49	13.33	7.7	7.9	6.2	1,237	2,346	59	273	0	0	0.0	79%	96%
3/9/07 17:00	16.77	3.50	13.33	7.7	8.0	6.2	1,234	2,329	59	274	0	0	0.0	80%	96%
3/9/07 18:00	16.81	3.50	13.32	7.7	8.0	6.2	1,233	2,327	58	275	0	0	0.0	79%	96%
3/9/07 19:00	16.82	3.50	13.32	7.7	8.0	6.2	1,232	2,325	58	275	0	0	0.0	79%	96%
3/9/07 20:00	16.83	3.50	13.32	7.7	8.0	6.2	1,233	2,322	59	276	0	0	0.0	79%	96%
3/9/07 21:00	16.81	3.50	13.32	7.7	8.0	6.2	1,233	2,320	59	276	0	0	0.0	79%	96%
3/9/07 22:00	16.86	3.50	13.31	7.7	8.0	6.2	1,234	2,317	59	276	0	0	0.0	79%	96%
3/9/07 23:00	16.85	3.50	13.30	7.7	8.0	6.2	1,234	2,316	59	276	0	0	0.0	79%	96%
3/10/07 0:00	16.83	3.50	13.31	7.7	8.0	6.2	1,235	2,313	60	276	0	0	0.0	79%	96%
3/10/07 1:00	16.81	3.50	13.30	7.7	8.0	6.2	1,236	2,312	60	276	0	0	0.0	79%	96%
3/10/07 2:00	16.90	3.50	13.29	7.7	7.9	6.2	1,234	2,307	59	275	0	0	0.0	79%	96%
3/10/07 3:00	16.86	3.50	13.29	7.7	7.9	6.2	1,235	2,305	59	276	0	0	0.0	79%	96%
3/10/07 4:00	16.76	3.50	13.27	7.7	8.0	6.2	1,235	2,307	60	276	0	0	0.0	79%	96%
3/10/07 5:00	16.84	3.50	13.27	7.7	8.0	6.2	1,234	2,303	60	276	0	0	0.0	79%	96%
3/10/07 6:00	16.81	3.50	13.27	7.7	8.0	6.2	1,234	2,299	60	276	0	0	0.0	79%	96%
3/10/07 7:00	16.83	3.50	13.29	7.7	7.9	6.2	1,234	2,298	59	276	0	0	0.0	79%	96%
3/10/07 8:00	16.78	3.49	13.25	7.7	7.9	6.2	1,232	2,294	59	275	0	0	0.0	79%	96%
3/10/07 12:00	16.84	3.37	13.34	7.6	7.9	6.4	1,233	3,039	94	276	0	0	0.0	79%	94%
3/10/07 13:00	16.66	3.37	13.25	7.6	7.9	6.3	1,236	2,906	83	276	0	0	0.0	80%	95%
3/10/07 14:00	16.65	3.37	13.22	7.6	7.9	6.3	1,239	2,834	78	277	0	0	0.0	80%	95%
3/10/07 15:00	16.68	3.37	13.20	7.6	7.9	6.3	1,238	2,790	74	278	0	0	0.0	79%	95%
3/10/07 16:00	16.63	3.38	13.18	7.6	7.9	6.2	1,237	2,749	70	278	0	0	0.0	79%	95%
3/10/07 17:00	16.61	3.38	13.10	7.7	7.9	6.2	1,234	2,709	68	278	0	0	0.0	79%	96%
3/10/07 18:00	16.51	3.38	13.08	7.7	7.9	6.2	1,233	2,680	66	279	0	0	0.0	79%	96%
3/10/07 19:00	16.50	3.39	13.07	7.7	7.9	6.2	1,232	2,658	65	279	0	0	0.0	79%	96%
3/10/07 20:00	16.48	3.39	13.06	7.7	7.9	6.2	1,232	2,641	63	280	0	0	0.0	79%	96%
3/10/07 21:00	16.48	3.39	13.05	7.7	7.9	6.2	1,232	2,626	62	280	0	0	0.0	79%	96%
3/10/07 22:00	16.48	3.39	13.04	7.7	7.9	6.2	1,232	2,612	62	281	0	0	0.0	79%	96%
3/10/07 23:00	16.49	3.39	13.03	7.7	7.9	6.2	1,232	2,600	61	281	0	0	0.0	79%	96%
3/11/07 0:00	16.43	3.39	13.04	7.7	7.9	6.2	1,232	2,590	61	281	0	0	0.0	79%	96%
3/11/07 1:00	16.57	3.39	13.03	7.7	7.9	6.2	1,233	2,581	61	281	0	0	0.0	79%	96%
3/11/07 3:00	16.48	3.39	13.02	7.7	7.9	6.2	1,233	2,572	60	282	0	0	0.0	79%	96%
3/11/07 4:00	16.51	3.39	13.02	7.7	7.9	6.2	1,233	2,565	60	282	0	0	0.0	79%	96%
3/11/07 5:00	16.52	3.39	13.02	7.7	7.9	6.2	1,233	2,557	60	282	0	0	0.0	79%	96%
3/11/07 6:00	16.41	3.39	13.01	7.7	7.9	6.2	1,233	2,551	59	282	0	0	0.0	79%	96%
3/11/07 7:00	16.47	3.39	13.00	7.7	7.9	6.2	1,234	2,546	59	282	0	0	0.0	79%	96%
3/11/07 8:00	16.42	3.39	13.00	7.7	7.9	6.2	1,233	2,539	59	282	0	0	0.0	79%	96%
3/11/07 9:00	16.36	3.38	12.96	7.7	7.9	6.2	1,231	2,531	58	281	0	0	0.0	79%	96%
3/11/07 10:00	16.38	3.38	12.94	7.7	7.9	6.2	1,232	2,529	57	279	0	0	0.0	79%	96%
3/11/07 11:00	16.40	3.37	12.92	7.6	7.9	6.1	1,234	2,530	56	278	0	0	0.0	79%	96%
3/11/07 12:00	16.34	3.36	12.88	7.6	7.9	6.1	1,236	2,530	56	277	0	0	0.0	79%	96%
3/11/07 13:00	16.38	3.35	12.88	7.6	7.9	6.1	1,238	2,529	55	277	0	0	0.0	79%	96%
3/11/07 14:00	16.27	3.35	12.87	7.6	7.9	6.1	1,239	2,526	55	276	0	0	0.0	79%	96%
3/11/07 15:00	16.20	3.35	12.85	7.6	7.9	6.1	1,240	2,523	55	277	0	0	0.0	79%	97%
3/11/07 16:00	16.25	3.35	12.84	7.6	7.9	6.1	1,242	2,520	54	277	0	0	0.0	79%	97%
3/11/07 17:00	16.29	3.36	12.83	7.6	7.9	6.1	1,241	2,515	54	278	0	0	0.0	79%	97%
3/11/07 18:00	16.28	3.38	12.82	7.6	7.9	6.1	1,235	2,500	53	279	0	0	0.0	79%	97%
3/11/07 19:00	16.28	3.38	12.82	7.7	7.9	6.1	1,233	2,491	52	281	0	0	0.0	79%	97%
3/11/07 20:00	16.39	3.39	12.83	7.7	8.0	6.1	1,232	2,485	52	281	0	0	0.0	78%	97%
3/11/07 21:00	16.32	3.40	12.83	7.7	7.9	6.1	1,232	2,481	52	282	0	0	0.0	79%	97%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/11/07 22:00	16.27	3.40	12.82	7.7	7.9	6.1	1,232	2,477	51	282	0	0	0.0	79%	97%
3/11/07 23:00	16.27	3.40	12.82	7.7	7.9	6.1	1,232	2,474	51	283	0	0	0.0	79%	97%
3/12/07 0:00	16.29	3.40	12.80	7.7	7.9	6.1	1,232	2,471	51	283	0	0	0.0	79%	97%
3/12/07 1:00	16.25	3.40	12.80	7.7	8.0	6.1	1,232	2,469	51	283	0	0	0.0	79%	97%
3/12/07 2:00	16.22	3.40	12.81	7.7	7.9	6.1	1,232	2,466	51	283	0	0	0.0	79%	97%
3/12/07 3:00	16.26	3.40	12.81	7.7	8.0	6.1	1,233	2,463	51	283	0	0	0.0	79%	97%
3/12/07 4:00	16.35	3.41	12.80	7.7	8.0	6.1	1,232	2,461	51	284	0	0	0.0	78%	97%
3/12/07 5:00	16.30	3.40	12.80	7.7	8.0	6.1	1,233	2,458	51	284	0	0	0.0	79%	97%
3/12/07 6:00	16.30	3.41	12.79	7.7	8.0	6.1	1,233	2,456	51	284	0	0	0.0	79%	97%
3/12/07 7:00	16.34	3.40	12.79	7.7	8.0	6.1	1,232	2,453	51	284	0	0	0.0	78%	97%
3/13/07 17:00	16.03	3.03	12.02	7.7	7.9	6.3	1,229	2,769	76	256	0	0	0.0	75%	95%
3/13/07 18:00	15.89	3.04	11.89	7.7	7.9	6.3	1,231	2,728	71	258	0	0	0.0	75%	96%
3/13/07 19:00	15.92	3.01	11.84	7.7	7.9	6.2	1,232	2,695	68	260	0	0	0.0	74%	96%
3/13/07 20:00	15.79	2.97	11.80	7.7	7.9	6.2	1,230	2,666	66	261	0	0	0.0	75%	96%
3/13/07 21:00	15.80	2.98	11.78	7.7	7.9	6.2	1,230	2,646	65	262	0	0	0.0	75%	96%
3/13/07 22:00	15.76	2.97	11.78	7.7	7.9	6.2	1,231	2,633	64	262	0	0	0.0	75%	96%
3/13/07 23:00	15.71	2.97	11.77	7.7	7.9	6.2	1,231	2,621	64	263	0	0	0.0	75%	96%
3/14/07 0:00	15.82	2.97	11.75	7.7	7.9	6.2	1,231	2,609	63	263	0	0	0.0	74%	96%
3/14/07 1:00	15.76	2.95	11.75	7.7	7.9	6.2	1,231	2,604	63	264	0	0	0.0	75%	96%
3/14/07 2:00	15.74	2.96	11.73	7.7	7.9	6.2	1,232	2,597	62	264	0	0	0.0	75%	96%
3/14/07 3:00	15.71	2.97	11.72	7.7	7.9	6.2	1,233	2,589	62	264	0	0	0.0	75%	96%
3/14/07 4:00	15.71	2.98	11.72	7.7	7.9	6.2	1,231	2,579	61	264	0	0	0.0	75%	96%
3/14/07 5:00	15.75	2.98	11.71	7.7	7.9	6.2	1,231	2,570	61	264	0	0	0.0	74%	96%
3/14/07 6:00	15.54	2.99	11.71	7.7	7.9	6.2	1,231	2,563	61	264	0	0	0.0	75%	96%
3/14/07 7:00	15.80	2.99	11.70	7.7	7.9	6.2	1,231	2,560	61	264	0	0	0.0	74%	96%
3/14/07 8:00	15.72	2.99	11.70	7.7	7.9	6.2	1,231	2,555	60	263	0	0	0.0	74%	96%
3/14/07 9:00	15.67	2.98	11.67	7.7	7.9	6.2	1,230	2,553	60	262	0	0	0.0	75%	96%
3/14/07 10:00	15.61	2.97	11.65	7.7	7.9	6.2	1,232	2,553	60	261	0	0	0.0	75%	96%
3/14/07 11:00	15.63	2.98	11.62	7.6	7.9	6.2	1,234	2,554	59	260	0	0	0.0	74%	96%
3/14/07 12:00	15.64	2.98	11.76	7.6	7.9	6.2	1,236	2,550	59	260	0	0	0.0	75%	96%
3/14/07 14:00	16.24	3.21	13.31	7.7	7.9	6.2	1,230	2,854	60	256	0	0	0.0	82%	96%
3/14/07 15:00	15.97	3.10	13.21	7.7	7.9	6.2	1,232	2,857	61	258	0	0	0.0	83%	96%
3/14/07 16:00	15.95	3.09	13.16	7.7	7.9	6.2	1,233	2,825	59	259	0	0	0.0	83%	96%
3/14/07 17:00	15.91	3.10	13.14	7.7	7.9	6.2	1,233	2,802	58	260	0	0	0.0	83%	96%
3/14/07 18:00	15.82	3.09	13.11	7.7	7.9	6.2	1,230	2,782	57	261	0	0	0.0	83%	96%
3/14/07 19:00	15.77	3.07	13.08	7.7	7.9	6.2	1,229	2,773	57	262	0	0	0.0	83%	96%
3/14/07 20:00	15.84	3.08	13.07	7.7	7.9	6.2	1,228	2,760	56	263	0	0	0.0	82%	96%
3/14/07 21:00	15.86	3.09	13.05	7.7	7.9	6.2	1,228	2,749	56	263	0	0	0.0	82%	96%
3/14/07 22:00	15.74	3.09	13.04	7.7	7.9	6.2	1,229	2,740	55	263	0	0	0.0	83%	96%
3/14/07 23:00	15.84	3.10	13.03	7.7	7.9	6.2	1,229	2,733	55	264	0	0	0.0	82%	96%
3/15/07 0:00	15.78	3.10	13.02	7.7	7.9	6.2	1,229	2,729	55	264	0	0	0.0	83%	96%
3/15/07 1:00	15.65	3.09	13.01	7.7	7.9	6.2	1,229	2,722	55	264	0	0	0.0	83%	96%
3/15/07 2:00	15.73	3.08	13.01	7.7	7.9	6.2	1,229	2,718	55	264	0	0	0.0	83%	96%
3/15/07 3:00	15.74	3.10	12.99	7.7	7.9	6.2	1,230	2,713	55	264	0	0	0.0	83%	96%
3/15/07 4:00	15.74	3.10	12.99	7.7	7.9	6.2	1,231	2,708	54	264	0	0	0.0	83%	96%
3/15/07 5:00	15.78	3.11	12.99	7.7	7.9	6.2	1,231	2,706	54	265	0	0	0.0	82%	96%
3/15/07 6:00	15.77	3.10	12.97	7.7	7.9	6.2	1,230	2,697	54	265	0	0	0.0	82%	96%
3/15/07 7:00	15.71	3.10	12.97	7.7	7.9	6.2	1,231	2,694	54	265	0	0	0.0	83%	96%
3/15/07 8:00	15.71	3.10	12.98	7.7	7.9	6.2	1,229	2,688	54	264	0	0	0.0	83%	96%
3/15/07 9:00	15.74	3.10	12.95	7.7	7.9	6.1	1,228	2,685	54	263	0	0	0.0	82%	96%
3/15/07 10:00	15.67	3.09	12.92	7.7	7.9	6.1	1,230	2,688	54	261	0	0	0.0	83%	96%
3/15/07 11:00	15.65	3.08	12.90	7.6	7.9	6.1	1,232	2,692	53	260	0	0	0.0	83%	96%
3/15/07 12:00	15.68	3.08	12.87	7.6	7.9	6.1	1,234	2,692	53	260	0	0	0.0	82%	96%
3/15/07 13:00	15.49	3.08	12.84	7.6	7.9	6.1	1,236	2,673	53	262	0	0	0.0	83%	96%
3/15/07 14:00	15.57	3.06	12.91	7.6	7.9	6.1	1,234	2,682	53	260	0	0	0.0	83%	96%
3/15/07 16:00	16.11	3.00	13.10	7.6	7.9	6.1	1,233	3,998	54	265	0	0	0.0	81%	96%
3/15/07 17:00	16.07	2.99	13.05	7.6	7.9	6.1	1,235	3,998	54	266	0	0	0.0	81%	96%
3/15/07 18:00	16.07	3.01	13.05	7.7	7.9	6.1	1,232	3,999	53	268	0	0	0.0	81%	97%
3/15/07 19:00	16.14	3.02	13.03	7.7	7.9	6.1	1,229	3,999	52	269	0	0	0.0	81%	97%
3/15/07 20:00	16.05	3.03	13.01	7.7	7.9	6.1	1,229	3,999	52	270	0	0	0.0	81%	97%
3/15/07 21:00	16.06	3.03	13.00	7.7	7.9	6.1	1,228	4,000	52	270	0	0	0.0	81%	97%
3/15/07 22:00	16.12	3.03	13.01	7.7	7.9	6.1	1,228	4,000	52	271	0	0	0.0	81%	97%
3/15/07 23:00	16.01	3.04	12.99	7.7	7.9	6.1	1,228	4,000	52	271	0	0	0.0	81%	97%
3/16/07 0:00	16.08	3.04	12.98	7.7	7.9	6.1	1,229	4,000	52	271	0	0	0.0	81%	97%
3/16/07 1:00	15.98	3.04	12.97	7.7	7.9	6.1	1,229	4,000	51	272	0	0	0.0	81%	97%
3/16/07 2:00	15.96	3.03	12.97	7.7	7.9	6.1	1,229	4,000	51	272	0	0	0.0	81%	97%
3/16/07 3:00	16.03	3.03	12.96	7.7	7.9	6.1	1,228	4,000	51	272	0	0	0.0	81%	97%
3/16/07 12:00	15.90	3.02	12.82	7.6	7.9	6.1	1,234	3,998	51	268	0	0	0.0	81%	97%
3/16/07 13:00	15.82	3.02	12.79	7.6	7.9	6.1	1,234	3,997	50	267	0	0	0.0	81%	97%
3/16/07 14:00	15.80	3.02	12.78	7.6	7.9	6.1	1,237	3,997	50	268	0	0	0.0	81%	97%
3/16/07 15:00	15.80	3.03	12.78	7.6	7.9	6.1	1,233	3,998	50	269	0	0	0.0	81%	97%
3/16/07 16:00	15.84	3.03	12.77	7.7	7.9	6.1	1,231	3,998	50	270	0	0	0.0	81%	97%
3/16/07 17:00	15.83	3.04	12.74	7.7	7.9	6.1	1,230	3,999	49	271	0	0	0.0	81%	97%
3/16/07 18:00	15.77	3.04	12.72	7.7	7.9	6.1	1,229	3,999	49	272	0	0	0.0	81%	97%
3/16/07 19:00	15.79	3.05	12.70	7.7	7.9	6.1	1,228	3,999	49	273	0	0	0.0	81%	97%
3/16/07 20:00	15.79	3.05	12.68	7.7	7.9	6.1	1,228	4,000	49	273	0	0	0.0	80%	97%
3/16/07 21:00	15.73	3.05	12.68	7.7	7.9	6.1	1,227	4,000	49	274	0	0	0.0	81%	97%
3/16/07 22:00	15.74	3.06	12.66	7.7	7.9	6.1	1,227	4,000	49	274	0	0	0.0	81%	97%
3/16/07 23:00	15.67	3.06	12.65	7.7	7.9	6.1	1,228	4,000	49	275	0	0	0.0	81%	97%
3/17/07 0:00	15.75	3.06	12.64	7.7	7.9	6.1	1,228	4,000	49	275	0	0	0.0	80%	97%
3/17/07 1:00	15.73	3.05	12.63	7.7	7.9	6.1	1,229	4,000	49	275	0	0	0.0	80%	97%
3/17/07 2:00	15.75	3.05	12.62	7.7	7.9	6.1	1,229	4,000	49	275	0	0	0.0	80%	97%
3/17/07 3:00	15.72	3.05	12.61	7.7	7.9	6.1	1,231	4,000	49	275	0	0	0.0	80%	97%
3/17/07 4:00	15.74	3.04	12.64	7.7	7.9	6.1	1,233	4,000	50	275	0	0	0.0	80%	97%
3/17/07 5:00	15.73	3.04	12.66	7.7	7.9	6.1	1,233	4,000	50	275	0	0	0.0	81%	97%
3/17/07 6:00	15.74	3.04	12.67	7.7	7.9	6.1	1,234	4,000	50	275	0	0	0.0	81%	97%
3/17/07 7:00	15.73	3.04	12.69	7.7	8.0	6.2	1,235	4,000	51	274	0	0	0.0	81%	97%
3/17/07 8:00	15.78	3.03	12.70	7.7	8.0	6.2	1,235	4,000	51	274	0	0	0.0	81%	97%
3/17/07 9:00	15.77	3.02	12.72	7.7	7.9	6.2	1,232	4,000	51	274	0	0	0.0	81%	97%
3/17/07 10:00	15.84	3.02	12.74	7.7	7.9	6.2	1,231	4,000	52	273	0	0	0.0	80%	97%
3/17/07 13:00	15.65	3.08	12.57	7.7	7.9	6.2	1,230	4,796	56	47	0	0	0.0	80%	96%
3/17/07 14:00	15.64	3.09	12.52	7.7	7.9	6.2	1,233	4,827	54	47	0	0	0.0	80%	96%
3/17/07 15:00	15.56	3.09	12.50	7.7	7.9	6.2	1,233	4,813	54	47	0	0	0.0	80%	96%
3/17/07 16:00	15.56	3.09	12.49	7.7	7.9	6.2	1,232	4,792	53	47	0	0	0.0	80%	97%
3/17/07 17:00	15.47	3.09	12.47	7.7	7.9	6.2	1,231	4,756	53	47	0	0	0.0	81%	97%
3/17/07 18:00	15.54	3.10	12.45	7.7	7.9	6.2	1,229	4,720	52	48	0	0	0.0	80%	97%
3/17/07 19:00	15.49	3.10	12.44	7.7	7.9	6.2	1,228	4,696	52	48	0	0	0.0	80%	97%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/17/07 20:00	15.56	3.10	12.43	7.7	7.9	6.2	1,229	4,684	52	48	0	0	0.0	80%	97%
3/17/07 21:00	15.55	3.10	12.42	7.7	7.9	6.2	1,230	4,673	51	48	0	0	0.0	80%	97%
3/17/07 22:00	15.49	3.10	12.40	7.7	7.9	6.2	1,229	4,660	51	48	0	0	0.0	80%	97%
3/17/07 23:00	15.58	3.11	12.39	7.7	7.9	6.2	1,229	4,646	51	48	0	0	0.0	80%	97%
3/18/07 0:00	15.49	3.11	12.39	7.7	7.9	6.2	1,228	4,636	51	48	250	0	211.5	80%	97%
3/18/07 1:00	15.49	3.11	12.38	7.7	7.9	6.2	1,229	4,628	51	48	250	0	211.7	80%	97%
3/18/07 2:00	15.53	3.11	12.38	7.7	7.9	6.2	1,230	4,629	51	48	250	0	211.6	80%	97%
3/18/07 3:00	15.51	3.11	12.37	7.7	7.9	6.2	1,230	4,626	51	48	250	0	211.5	80%	97%
3/18/07 4:00	15.52	3.11	12.37	7.7	7.9	6.1	1,230	4,615	51	48	250	0	211.6	80%	97%
3/18/07 5:00	15.51	3.11	12.36	7.7	7.9	6.1	1,230	4,604	50	48	250	0	211.7	80%	97%
3/18/07 6:00	15.47	3.10	12.35	7.7	7.9	6.1	1,231	4,600	50	48	250	0	211.6	80%	97%
3/18/07 7:00	15.47	3.10	12.35	7.7	7.9	6.1	1,231	4,592	50	48	250	0	211.7	80%	97%
3/18/07 8:00	15.46	3.10	12.34	7.7	7.9	6.1	1,230	4,581	50	48	250	0	211.5	80%	97%
3/18/07 9:00	15.51	3.10	12.33	7.7	7.9	6.1	1,229	4,573	50	47	250	0	210.9	80%	97%
3/18/07 10:00	15.41	3.09	12.33	7.7	7.9	6.1	1,230	4,587	50	47	250	0	209.9	80%	97%
3/18/07 11:00	15.43	3.08	12.31	7.7	7.9	6.1	1,232	4,596	50	47	250	0	209.2	80%	97%
3/18/07 12:00	15.30	3.08	12.31	7.7	7.9	6.1	1,234	4,591	50	47	250	0	209.1	81%	97%
3/18/07 13:00	15.42	3.08	12.31	7.7	7.9	6.1	1,235	4,589	51	47	250	0	209.1	80%	97%
3/18/07 14:00	15.38	3.08	12.31	7.7	7.9	6.1	1,236	4,586	51	47	250	0	209.1	80%	97%
3/18/07 15:00	15.39	3.08	12.30	7.7	7.9	6.1	1,237	4,579	50	47	250	0	209.4	80%	97%
3/18/07 16:00	15.38	3.08	12.30	7.7	7.9	6.1	1,233	4,556	50	47	250	0	209.9	80%	97%
3/18/07 17:00	15.42	3.09	12.29	7.7	7.9	6.1	1,232	4,536	50	47	250	0	210.5	80%	97%
3/18/07 18:00	15.43	3.10	12.26	7.7	7.9	6.2	1,229	4,506	50	48	250	0	211.7	80%	97%
3/18/07 19:00	15.39	3.10	12.27	7.7	7.9	6.2	1,228	4,487	50	48	250	0	212.2	80%	97%
3/18/07 20:00	15.38	3.11	12.27	7.7	7.9	6.2	1,228	4,476	50	48	250	0	212.5	80%	97%
3/18/07 21:00	15.40	3.10	12.26	7.7	7.9	6.1	1,229	4,472	50	48	250	0	212.6	80%	97%
3/18/07 22:00	15.40	3.11	12.25	7.7	7.9	6.1	1,229	4,461	49	48	250	0	212.8	80%	97%
3/18/07 23:00	15.41	3.11	12.24	7.7	7.9	6.1	1,229	4,449	49	48	250	0	213.0	80%	97%
3/19/07 0:00	15.39	3.10	12.25	7.7	7.9	6.1	1,229	4,448	49	48	250	0	213.0	80%	97%
3/19/07 1:00	15.33	3.11	12.24	7.7	7.9	6.1	1,230	4,443	49	48	250	0	212.9	80%	97%
3/19/07 2:00	15.36	3.10	12.23	7.7	7.9	6.1	1,230	4,437	49	48	250	0	213.0	80%	97%
3/19/07 3:00	15.38	3.11	12.22	7.7	7.9	6.1	1,231	4,432	49	48	250	0	213.1	80%	97%
3/19/07 4:00	15.28	3.11	12.22	7.7	7.9	6.1	1,232	4,427	49	48	250	0	213.2	80%	97%
3/19/07 5:00	15.31	3.11	12.21	7.7	7.9	6.1	1,233	4,421	49	48	250	0	213.4	80%	97%
3/19/07 6:00	15.30	3.11	12.21	7.7	7.9	6.1	1,232	4,411	49	48	250	0	213.5	80%	97%
3/19/07 7:00	15.40	3.11	12.21	7.7	7.9	6.1	1,232	4,401	49	48	250	0	213.6	79%	97%
3/19/07 8:00	15.36	3.11	12.20	7.7	7.9	6.1	1,232	4,398	49	48	250	0	213.5	80%	97%
3/19/07 9:00	15.28	3.10	12.19	7.7	7.9	6.1	1,228	4,382	49	47	250	0	212.6	80%	97%
3/19/07 10:00	15.31	3.10	12.19	7.7	7.9	6.1	1,230	4,387	49	47	250	0	212.0	80%	97%
3/19/07 11:00	15.31	3.09	12.19	7.7	7.9	6.1	1,231	4,387	49	47	250	0	211.5	80%	97%
3/19/07 12:00	15.30	3.09	12.19	7.7	7.9	6.1	1,232	4,395	49	47	250	0	212.1	80%	97%
3/19/07 13:00	15.27	3.09	12.19	7.7	7.9	6.1	1,235	4,400	49	47	250	0	212.3	80%	97%
3/19/07 14:00	15.29	3.09	12.19	7.7	7.9	6.1	1,237	4,401	50	47	250	0	212.4	80%	97%
3/19/07 15:00	15.41	3.09	12.20	7.7	7.9	6.1	1,237	4,397	49	47	250	0	212.8	79%	97%
3/19/07 16:00	15.33	3.10	12.19	7.7	7.9	6.1	1,234	4,368	49	47	250	0	213.8	80%	97%
3/19/07 17:00	15.32	3.11	12.20	7.7	7.9	6.1	1,231	4,343	49	47	250	0	214.7	80%	97%
3/19/07 18:00	15.36	3.11	12.19	7.7	7.9	6.1	1,230	4,326	49	48	250	0	215.5	79%	97%
3/19/07 19:00	15.33	3.12	12.19	7.7	7.9	6.1	1,229	4,316	49	48	250	0	215.8	80%	97%
3/19/07 20:00	15.37	3.12	12.19	7.7	7.9	6.1	1,229	4,308	48	48	250	0	216.1	79%	97%
3/19/07 21:00	15.30	3.12	12.19	7.7	7.9	6.1	1,229	4,298	48	48	250	0	216.3	80%	97%
3/19/07 22:00	15.35	3.12	12.20	7.7	7.9	6.1	1,229	4,293	48	48	250	0	216.3	80%	97%
3/19/07 23:00	15.39	3.12	12.19	7.7	7.9	6.1	1,230	4,289	48	48	250	0	216.4	79%	97%
3/20/07 0:00	15.35	3.12	12.19	7.7	7.9	6.1	1,231	4,284	48	48	250	0	216.5	79%	97%
3/20/07 1:00	15.40	3.12	12.19	7.7	7.9	6.1	1,231	4,280	48	48	250	0	216.4	79%	97%
3/20/07 2:00	15.36	3.12	12.17	7.7	7.9	6.1	1,231	4,276	48	48	250	0	216.2	79%	97%
3/20/07 3:00	15.30	3.12	12.17	7.7	7.9	6.1	1,230	4,266	48	48	250	0	216.3	80%	97%
3/20/07 4:00	15.35	3.12	12.16	7.7	7.9	6.1	1,232	4,263	48	48	250	0	216.4	79%	97%
3/20/07 5:00	15.35	3.12	12.17	7.7	7.9	6.1	1,232	4,260	48	48	250	0	216.4	79%	97%
3/20/07 6:00	15.32	3.12	12.17	7.7	7.9	6.1	1,232	4,253	48	48	250	0	216.5	80%	97%
3/20/07 7:00	15.30	3.12	12.16	7.7	7.9	6.1	1,233	4,245	48	48	250	0	216.6	80%	97%
3/20/07 8:00	15.36	3.12	12.15	7.7	7.9	6.1	1,234	4,242	48	48	250	0	216.9	79%	97%
3/20/07 9:00	15.30	3.12	12.14	7.7	7.9	6.1	1,231	4,234	48	47	250	0	216.7	79%	97%
3/20/07 10:00	15.32	3.12	12.15	7.7	7.9	6.1	1,230	4,226	48	47	250	0	216.4	79%	97%
3/20/07 11:00	15.31	3.12	12.13	7.7	7.9	6.1	1,231	4,221	48	47	250	0	216.3	79%	97%
3/20/07 12:00	15.31	3.12	12.13	7.7	7.9	6.1	1,232	4,201	48	47	250	0	216.3	79%	97%
3/20/07 13:00	15.30	3.12	12.12	7.7	7.9	6.1	1,232	4,199	48	47	250	0	216.3	79%	97%
3/20/07 14:00	15.23	3.12	12.11	7.7	7.9	6.1	1,233	4,198	48	47	250	0	216.5	80%	97%
3/20/07 15:00	15.29	3.13	12.11	7.7	7.9	6.1	1,234	4,194	48	47	250	0	216.6	79%	97%
3/20/07 16:00	15.25	3.12	12.11	7.7	7.9	6.1	1,233	4,189	48	47	250	0	216.7	79%	97%
3/20/07 17:00	15.30	3.12	12.10	7.7	7.9	6.1	1,233	4,178	48	47	250	0	216.9	79%	97%
3/20/07 18:00	15.25	3.13	12.10	7.7	7.9	6.1	1,229	4,158	48	48	250	0	217.2	79%	97%
3/20/07 19:00	15.28	3.13	12.09	7.7	7.9	6.1	1,229	4,148	48	48	250	0	217.4	79%	97%
3/20/07 20:00	15.29	3.13	12.09	7.7	7.9	6.1	1,229	4,142	48	48	250	0	217.6	79%	97%
3/20/07 21:00	15.28	3.13	12.07	7.7	7.9	6.1	1,228	4,126	48	48	250	0	217.9	79%	97%
3/20/07 22:00	15.26	3.13	12.07	7.7	7.9	6.1	1,227	4,118	48	48	250	0	218.1	79%	97%
3/20/07 23:00	15.24	3.13	12.06	7.7	7.9	6.1	1,228	4,115	48	48	250	0	218.3	79%	97%
3/21/07 0:00	15.26	3.13	12.06	7.7	7.9	6.1	1,227	4,107	47	48	250	0	218.4	79%	97%
3/21/07 1:00	15.19	3.13	12.07	7.7	7.9	6.1	1,229	4,105	48	48	250	0	218.3	80%	97%
3/21/07 2:00	15.21	3.13	12.06	7.7	7.9	6.1	1,229	4,098	48	48	250	0	218.3	79%	97%
3/21/07 3:00	15.24	3.13	12.05	7.7	7.9	6.1	1,229	4,099	48	48	250	0	218.3	79%	97%
3/21/07 4:00	15.25	3.13	12.05	7.7	7.9	6.1	1,229	4,090	48	48	250	0	218.3	79%	97%
3/21/07 5:00	15.22	3.14	12.05	7.7	7.9	6.1	1,230	4,092	47	48	250	0	218.4	79%	97%
3/21/07 6:00	15.21	3.13	12.04	7.7	7.9	6.1	1,230	4,085	47	48	250	0	218.5	79%	97%
3/21/07 7:00	15.21	3.14	12.03	7.7	7.9	6.1	1,231	4,072	47	48	250	0	218.8	79%	97%
3/21/07 8:00	15.23	3.14	12.03	7.7	7.9	6.1	1,232	4,071	47	48	250	0	218.6	79%	97%
3/21/07 9:00	15.23	3.13	12.03	7.7	7.9	6.1	1,229	4,062	47	48	250	0	217.9	79%	97%
3/21/07 10:00	15.19	3.13	12.01	7.7	7.9	6.1	1,230	4,064	47	47	250	0	217.4	79%	97%
3/21/07 11:00	15.19	3.12	12.01	7.7	7.9	6.1	1,230	4,066	48	47	250	0	216.5	79%	97%
3/21/07 12:00	15.20	3.12	11.99	7.7	7.9	6.1	1,232	4,069	48	47	250	0	216.2	79%	97%
3/21/07 13:00	15.14	3.11	11.99	7.7	7.9	6.1	1,233	4,070	48	47	250	0	215.6	79%	97%
3/21/07 14:00	15.19	3.11	11.98	7.7	7.9	6.1	1,233	4,073	48	47	250	0	215.4	79%	97%
3/21/07 15:00	15.12	3.11	11.98	7.7	7.9	6.1	1,234	4,071	48	47	250	0	215.3	79%	97%
3/21/07 16:00	15.18	3.11	11.98	7.7	7.9	6.1	1,233	4,057	48	47	250	0	216.0	79%	97%
3/21/07 17:00	15.13	3.12	11.97	7.7	7.9	6.1	1,231	4,041	48	47	250	0	216.5	79%	97%
3/21/07 18:00	15.06	3.13	11.95	7.7	7.9	6.1	1,229	4,020	47	47	250	0	217.3	79%	97%
3/21/07 19:00	15.13	3.13	11.93	7.7	7.9	6.1	1,228	4,006	47	48	250	0	217.9	79%	97%
3/21/07 20:00	15.08	3.13	11.92	7.7	7.9	6.1	1,228	3,997	47	48	250	0	218.4	79%	97%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/21/07 21:00	15.09	3.13	11.92	7.7	7.9	6.1	1,227	3,990	47	48	250	0	218.7	79%	97%
3/21/07 22:00	15.09	3.14	11.92	7.7	7.9	6.1	1,227	3,980	47	48	250	0	219.0	79%	97%
3/21/07 23:00	15.08	3.14	11.91	7.7	7.9	6.1	1,227	3,970	47	48	250	0	219.3	79%	97%
3/22/07 0:00	15.12	3.14	11.91	7.7	7.9	6.1	1,227	3,962	47	48	250	2	219.4	79%	97%
3/22/07 1:00	15.12	3.14	11.90	7.7	7.9	6.1	1,227	3,957	47	48	250	2	219.6	79%	97%
3/22/07 2:00	15.08	3.14	11.90	7.7	7.9	6.1	1,227	3,953	47	48	250	2	219.9	79%	97%
3/22/07 3:00	15.12	3.14	11.90	7.7	7.9	6.1	1,227	3,947	47	48	250	2	220.0	79%	97%
3/22/07 4:00	15.11	3.14	11.90	7.7	7.9	6.1	1,228	3,945	47	48	250	2	220.1	79%	97%
3/22/07 5:00	15.04	3.14	11.91	7.7	7.9	6.1	1,229	3,945	47	48	250	2	220.1	79%	97%
3/22/07 6:00	15.08	3.14	11.92	7.7	7.9	6.1	1,229	3,944	47	48	250	2	220.2	79%	97%
3/22/07 7:00	15.11	3.14	11.91	7.7	7.9	6.1	1,230	3,942	48	48	250	2	220.1	79%	97%
3/22/07 8:00	15.13	3.13	11.94	7.7	7.9	6.1	1,228	3,943	48	48	250	1	219.3	79%	97%
3/22/07 9:00	15.13	3.13	11.92	7.7	7.9	6.1	1,229	3,950	48	48	250	1	218.6	79%	97%
3/22/07 10:00	15.12	3.12	11.93	7.7	7.9	6.1	1,229	3,955	48	47	250	1	217.5	79%	97%
3/22/07 11:00	15.08	3.11	11.91	7.7	7.9	6.1	1,231	3,961	48	47	250	1	216.6	79%	97%
3/22/07 15:00	16.32	3.11	13.20	7.7	7.9	6.6	1,228	4,851	125	248	244	1	206.0	81%	92%
3/22/07 16:00	16.13	3.11	13.06	7.7	7.9	6.5	1,230	4,889	116	248	244	1	206.3	81%	92%
3/22/07 17:00	16.25	3.11	13.02	7.7	7.9	6.5	1,232	4,896	111	249	245	1	206.0	80%	93%
3/22/07 18:00	16.21	3.11	13.01	7.7	7.9	6.5	1,231	4,885	107	249	245	1	205.7	80%	93%
3/22/07 19:00	16.14	3.12	12.98	7.7	7.9	6.5	1,228	4,869	104	250	246	2	205.6	81%	93%
3/22/07 20:00	16.16	3.12	12.98	7.7	7.9	6.5	1,228	4,857	101	251	247	2	205.3	80%	93%
3/22/07 21:00	16.06	3.13	12.95	7.7	7.9	6.5	1,227	4,852	100	251	247	2	205.5	81%	93%
3/22/07 22:00	16.09	3.12	12.97	7.7	7.9	6.5	1,227	4,846	99	252	248	2	205.2	81%	94%
3/22/07 23:00	16.19	3.12	12.96	7.7	7.9	6.5	1,228	4,847	97	252	248	2	205.5	80%	94%
3/23/07 0:00	16.20	3.12	12.95	7.7	7.9	6.5	1,230	4,847	96	252	248	0	205.3	80%	94%
3/23/07 1:00	16.13	3.12	12.95	7.7	7.9	6.4	1,229	4,845	95	252	248	0	205.4	80%	94%
3/23/07 2:00	16.07	3.12	12.95	7.7	7.9	6.4	1,228	4,830	94	252	249	0	205.2	81%	94%
3/23/07 3:00	16.10	3.13	12.95	7.7	7.9	6.4	1,226	4,818	94	253	249	0	205.2	81%	94%
3/23/07 4:00	16.03	3.13	12.93	7.7	8.0	6.4	1,227	4,806	93	253	249	0	205.4	81%	94%
3/23/07 5:00	16.01	3.13	12.94	7.7	7.9	6.4	1,227	4,799	93	253	249	0	205.1	81%	94%
3/23/07 6:00	16.15	3.13	12.95	7.7	7.9	6.4	1,228	4,790	92	253	249	0	205.2	80%	94%
3/23/07 7:00	16.16	3.12	12.95	7.7	7.9	6.4	1,228	4,788	92	253	249	0	205.2	80%	94%
3/23/07 8:00	16.11	3.12	12.95	7.7	7.9	6.4	1,226	4,777	91	252	248	0	205.4	80%	94%
3/23/07 9:00	15.96	3.12	12.94	7.7	7.9	6.4	1,227	4,785	90	251	247	0	205.7	81%	94%
3/23/07 10:00	15.94	3.11	12.92	7.7	7.9	6.4	1,229	4,789	89	250	246	0	206.1	81%	94%
3/23/07 11:00	15.91	3.10	12.90	7.7	7.9	6.4	1,230	4,795	89	249	245	0	206.3	81%	94%
3/23/07 12:00	16.00	3.10	12.87	7.7	7.9	6.4	1,232	4,802	87	248	244	0	206.4	81%	94%
3/23/07 13:00	15.93	3.09	12.89	7.7	7.9	6.4	1,233	4,801	87	248	244	0	206.4	81%	94%
3/23/07 15:00	16.08	3.10	12.90	7.7	7.9	6.4	1,233	4,778	89	249	244	0	206.1	80%	94%
3/23/07 16:00	15.97	3.10	12.88	7.7	7.9	6.4	1,233	4,768	87	249	245	0	206.1	81%	94%
3/23/07 17:00	16.03	3.11	12.88	7.7	7.9	6.4	1,230	4,737	85	250	246	0	205.9	80%	94%
3/23/07 18:00	16.01	3.12	12.87	7.7	7.9	6.4	1,228	4,699	84	251	247	0	205.7	80%	95%
3/23/07 19:00	16.08	3.12	12.85	7.7	7.9	6.4	1,226	4,675	82	252	247	0	205.5	80%	95%
3/23/07 20:00	15.95	3.12	12.86	7.7	8.0	6.4	1,226	4,654	81	252	248	0	205.3	81%	95%
3/23/07 21:00	15.99	3.13	12.85	7.7	7.9	6.4	1,226	4,646	80	252	248	0	205.3	80%	95%
3/23/07 22:00	16.03	3.13	12.84	7.7	7.9	6.4	1,226	4,634	80	253	248	0	205.1	80%	95%
3/23/07 23:00	16.05	3.13	12.84	7.7	7.9	6.4	1,227	4,624	79	253	249	0	205.3	80%	95%
3/24/07 0:00	16.03	3.12	12.83	7.7	7.9	6.4	1,227	4,612	79	253	249	0	205.2	80%	95%
3/24/07 1:00	15.86	3.13	12.85	7.7	7.9	6.4	1,227	4,602	78	253	249	0	205.1	81%	95%
3/24/07 2:00	16.07	3.12	12.83	7.7	7.9	6.3	1,227	4,588	78	253	249	0	205.3	80%	95%
3/24/07 3:00	16.05	3.12	12.84	7.7	7.9	6.3	1,227	4,577	77	253	249	0	205.2	80%	95%
3/24/07 4:00	15.94	3.13	12.82	7.7	7.9	6.3	1,227	4,567	77	253	249	0	205.2	81%	95%
3/24/07 5:00	15.87	3.13	12.82	7.7	7.9	6.3	1,227	4,549	77	254	249	0	205.1	81%	95%
3/24/07 6:00	15.98	3.13	12.84	7.7	7.9	6.3	1,228	4,546	77	253	249	0	205.1	80%	95%
3/24/07 7:00	15.91	3.12	12.83	7.7	7.9	6.3	1,227	4,537	76	253	249	0	205.3	81%	95%
3/24/07 8:00	15.95	3.13	12.82	7.7	7.9	6.3	1,227	4,522	76	253	249	0	205.2	80%	95%
3/24/07 10:00	15.81	2.96	12.79	7.7	7.9	6.4	1,226	5,060	82	252	248	0	205.4	81%	95%
3/24/07 11:00	15.89	2.95	12.74	7.7	7.9	6.3	1,227	5,081	80	251	248	0	205.5	80%	95%
3/24/07 12:00	15.84	2.95	12.75	7.7	7.9	6.3	1,228	5,097	79	251	248	0	205.7	81%	95%
3/24/07 13:00	15.76	2.95	12.74	7.7	7.9	6.3	1,228	5,109	78	251	248	0	205.5	81%	95%
3/24/07 14:00	15.67	2.95	12.75	7.7	7.9	6.3	1,228	5,122	77	251	247	0	205.6	81%	95%
3/24/07 15:00	15.67	2.95	12.73	7.7	7.9	6.3	1,229	5,130	76	251	247	0	205.8	81%	95%
3/24/07 16:00	15.72	2.95	12.73	7.7	7.9	6.3	1,228	5,115	75	252	248	0	205.3	81%	95%
3/24/07 17:00	15.75	2.95	12.73	7.7	7.9	6.3	1,227	5,104	75	252	248	0	205.4	81%	95%
3/24/07 18:00	15.76	2.96	12.71	7.7	7.9	6.3	1,226	5,090	74	252	249	0	205.4	81%	95%
3/24/07 19:00	15.78	2.96	12.70	7.7	8.0	6.3	1,226	5,085	74	252	249	0	205.4	81%	95%
3/24/07 20:00	15.77	2.96	12.69	7.7	7.9	6.3	1,227	5,074	73	252	249	0	205.3	81%	95%
3/24/07 21:00	15.64	2.96	12.71	7.7	7.9	6.3	1,229	5,079	73	252	249	0	205.2	81%	95%
3/24/07 22:00	15.76	2.96	12.70	7.7	7.9	6.3	1,229	5,087	73	253	249	0	205.2	81%	95%
3/24/07 23:00	15.73	2.95	12.70	7.7	7.9	6.3	1,229	5,082	72	253	249	0	205.3	81%	95%
3/25/07 0:00	15.81	2.96	12.70	7.7	7.9	6.3	1,230	5,073	72	253	249	0	205.3	80%	95%
3/25/07 1:00	15.70	2.95	12.69	7.7	7.9	6.3	1,230	5,067	72	253	249	0	205.1	81%	95%
3/25/07 2:00	15.63	2.95	12.68	7.7	7.9	6.3	1,231	5,044	71	253	249	0	205.2	81%	95%
3/25/07 3:00	15.70	2.95	12.68	7.7	7.9	6.3	1,231	5,034	71	253	249	0	205.3	81%	95%
3/25/07 4:00	15.70	2.95	12.66	7.7	7.9	6.3	1,231	5,026	71	253	250	0	205.2	81%	95%
3/25/07 5:00	15.56	2.95	12.67	7.7	7.9	6.3	1,231	5,020	70	253	250	0	205.3	82%	95%
3/25/07 6:00	15.68	2.96	12.66	7.7	7.9	6.3	1,232	5,011	70	253	250	0	205.4	81%	95%
3/25/07 7:00	15.66	2.96	12.67	7.7	7.9	6.3	1,232	5,005	70	253	250	0	205.3	81%	95%
3/25/07 8:00	15.65	2.96	12.67	7.7	7.9	6.3	1,231	4,997	69	253	250	0	205.3	81%	95%
3/25/07 9:00	15.68	2.96	12.67	7.7	7.9	6.3	1,227	4,977	69	253	249	0	205.3	81%	95%
3/25/07 10:00	15.59	2.96	12.66	7.7	7.9	6.3	1,227	4,967	69	252	249	0	205.4	81%	95%
3/25/07 11:00	15.68	2.95	12.65	7.7	7.9	6.3	1,227	4,988	69	251	248	0	205.7	81%	95%
3/25/07 12:00	15.73	2.94	12.65	7.7	7.9	6.3	1,228	4,995	69	251	247	0	205.7	80%	96%
3/25/07 13:00	15.50	2.94	12.63	7.7	7.9	6.3	1,230	4,980	68	250	247	0	206.0	82%	95%
3/25/07 14:00	15.54	2.93	12.63	7.7	7.9	6.3	1,232	4,978	68	250	247	0	206.0	81%	95%
3/25/07 15:00	15.72	2.94	12.62	7.7	7.9	6.3	1,231	4,975	68	251	247	0	205.8	80%	96%
3/25/07 16:00	15.67	2.94	12.63	7.7	7.9	6.3	1,229	4,960	67	251	248	0	205.7	81%	96%
3/25/07 17:00	15.49	2.95	12.62	7.7	7.9	6.3	1,228	4,944	67	252	248	0	205.6	82%	96%
3/25/07 18:00	15.77	2.95	12.62	7.7	7.9	6.3	1,227	4,932	67	253	249	0	205.4	80%	96%
3/25/07 19:00	15.66	2.95	12.62	7.7	8.0	6.3	1,226	4,918	66	253	250	0	205.3	81%	96%
3/25/07 20:00	15.52	2.96	12.62	7.7	8.0	6.3	1,226	4,900	66	254	250	0	205.2	81%	96%
3/25/07 21:00	15.45	2.96	12.60	7.7	8.0	6.3	1,226	4,886	66	254	251	0	205.1	82%	96%
3/25/07 22:00	15.57	2.96	12.60	7.7	8.0	6.3	1,226	4,878	66	254	251	0	205.1	81%	96%
3/25/07 23:00	15.58	2.96	12.59	7.7	8.0	6.3	1,226	4,871	66	254	251	0	205.2	81%	96%
3/26/07 0:00	15.57	2.96	12.59	7.7	8.0	6.3	1,227	4,870	65	254	251	0	205.2	81%	96%
3/26/07 1:00	15.63	2.96	12.58	7.7	7.9	6.3	1,228	4,868	65	254	251	0	205.1	81%	96%
3/26/07 2:00	15.60	2.96	12.59	7.7	7.9	6.3	1,228	4,866	65	254	251	0	205.1	81%	96%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/26/07 3:00	15.67	2.96	12.59	7.7	7.9	6.3	1,227	4,863	65	254	250	0	205.2	80%	96%
3/26/07 4:00	15.65	2.96	12.60	7.7	7.9	6.3	1,226	4,858	65	254	250	0	205.2	81%	96%
3/26/07 5:00	15.55	2.96	12.58	7.7	7.9	6.3	1,228	4,858	65	254	250	0	205.6	81%	96%
3/26/07 6:00	15.57	2.96	12.58	7.7	7.9	6.3	1,228	4,851	64	254	250	0	205.4	81%	96%
3/26/07 7:00	15.50	2.96	12.57	7.7	7.9	6.3	1,229	4,851	64	254	251	0	205.4	81%	96%
3/26/07 8:00	15.63	2.96	12.57	7.7	7.9	6.3	1,228	4,842	64	254	250	0	205.4	80%	96%
3/26/07 9:00	15.55	2.95	12.57	7.7	7.9	6.3	1,228	4,844	64	253	249	0	205.4	81%	96%
3/26/07 10:00	15.52	2.94	12.54	7.7	7.9	6.3	1,229	4,854	64	252	248	0	205.9	81%	96%
3/26/07 11:00	15.56	2.95	12.52	7.7	7.9	6.3	1,231	4,860	64	252	248	0	206.1	81%	96%
3/26/07 12:00	15.47	2.94	12.54	7.7	7.9	6.3	1,233	4,868	64	251	248	0	205.9	81%	96%
3/26/07 13:00	15.59	2.94	12.53	7.7	7.9	6.2	1,233	4,869	64	252	248	0	205.7	80%	96%
3/28/07 3:00	15.88	2.83	12.90	7.7	8.0	6.2	1,226	5,193	65	265	262	0	205.0	81%	96%
3/28/07 4:00	15.65	2.83	12.88	7.7	8.0	6.2	1,227	5,192	64	265	262	0	204.8	82%	96%
3/28/07 5:00	15.83	2.84	12.88	7.7	8.0	6.2	1,228	5,207	64	265	262	0	204.9	81%	96%
3/28/07 6:00	15.77	2.84	12.88	7.7	8.0	6.2	1,227	5,199	64	265	262	0	204.7	82%	96%
3/28/07 7:00	15.72	2.84	12.87	7.7	8.0	6.2	1,228	5,197	64	265	262	0	205.0	82%	96%
3/28/07 8:00	15.70	2.83	12.88	7.7	7.9	6.2	1,226	5,193	64	264	261	0	205.1	82%	96%
3/28/07 9:00	15.68	2.82	12.87	7.7	7.9	6.2	1,227	5,204	64	263	260	0	205.3	82%	96%
3/28/07 10:00	15.68	2.82	12.84	7.7	7.9	6.2	1,228	5,196	64	262	259	0	205.7	82%	96%
3/28/07 11:00	15.61	2.82	12.87	7.7	7.9	6.2	1,229	5,208	64	262	259	0	205.4	83%	96%
3/28/07 12:00	15.75	2.82	12.88	7.7	7.9	6.2	1,228	5,216	63	262	259	0	205.7	82%	96%
3/28/07 13:00	15.60	2.82	12.85	7.7	7.9	6.2	1,230	5,216	63	261	258	0	205.8	82%	96%
3/28/07 14:00	15.70	2.82	12.85	7.7	7.9	6.2	1,229	5,220	63	261	258	0	205.7	82%	96%
3/28/07 15:00	15.74	2.81	12.84	7.7	7.9	6.2	1,231	5,222	63	261	258	0	206.0	82%	96%
3/28/07 16:00	15.67	2.81	12.83	7.7	7.9	6.2	1,232	5,217	63	261	258	0	206.0	82%	96%
3/28/07 17:00	15.78	2.82	12.81	7.7	7.9	6.2	1,232	5,216	63	261	258	0	205.9	81%	96%
3/28/07 18:00	15.69	2.82	12.81	7.7	7.9	6.3	1,229	5,197	63	262	259	0	205.8	82%	96%
3/28/07 19:00	15.65	2.83	12.81	7.7	8.0	6.3	1,226	5,171	62	263	260	0	205.3	82%	96%
3/28/07 20:00	15.67	2.84	12.82	7.7	8.0	6.3	1,225	5,157	62	264	261	0	205.1	82%	96%
3/28/07 21:00	15.63	2.83	12.79	7.7	8.0	6.3	1,225	5,148	62	264	261	0	205.2	82%	96%
3/28/07 22:00	15.60	2.84	12.81	7.7	8.0	6.2	1,225	5,141	62	265	262	0	204.9	82%	96%
3/28/07 23:00	15.62	2.84	12.79	7.7	8.0	6.2	1,225	5,139	62	265	262	0	204.9	82%	96%
3/29/07 0:00	15.54	2.85	12.78	7.7	8.0	6.2	1,226	5,132	61	265	262	0	205.0	82%	96%
3/29/07 1:00	15.71	2.85	12.77	7.7	8.0	6.2	1,226	5,129	61	265	262	0	205.1	81%	96%
3/29/07 2:00	15.62	2.85	12.78	7.7	8.0	6.2	1,226	5,121	61	265	262	0	204.9	82%	96%
3/29/07 3:00	15.68	2.85	12.78	7.7	8.0	6.2	1,225	5,115	61	265	262	0	205.0	82%	96%
3/29/07 4:00	15.62	2.85	12.75	7.7	8.0	6.2	1,225	5,110	61	265	262	0	205.0	82%	96%
3/29/07 5:00	15.64	2.86	12.76	7.7	8.0	6.2	1,225	5,105	61	266	263	0	205.0	82%	96%
3/29/07 6:00	15.80	2.86	12.75	7.7	8.0	6.2	1,226	5,107	61	266	263	0	204.8	81%	96%
3/29/07 7:00	15.73	2.86	12.78	7.7	8.0	6.2	1,226	5,109	61	265	263	0	204.9	81%	96%
3/29/07 8:00	15.74	2.85	12.77	7.7	8.0	6.2	1,224	5,103	61	264	262	0	146.4	81%	96%
3/29/07 9:00	15.57	2.84	12.76	7.7	7.9	6.2	1,225	5,117	61	263	260	0	205.5	82%	96%
3/29/07 10:00	15.56	2.84	12.76	7.7	7.9	6.2	1,227	5,132	61	262	259	0	205.8	82%	96%
3/29/07 11:00	15.52	2.83	12.74	7.7	7.9	6.2	1,229	5,144	61	261	258	0	206.0	82%	96%
3/29/07 12:00	15.62	2.83	12.78	7.7	7.9	6.2	1,230	5,160	61	261	258	0	206.1	82%	96%
3/29/07 13:00	15.88	2.87	13.08	7.7	7.9	6.2	1,232	5,207	60	267	264	0	206.3	82%	96%
3/29/07 14:00	15.98	2.87	13.09	7.7	7.9	6.2	1,233	5,212	60	267	264	0	206.3	82%	96%
3/29/07 15:00	15.95	2.87	13.09	7.7	7.9	6.2	1,234	5,213	60	267	264	0	206.3	82%	96%
3/29/07 16:00	16.01	2.88	13.08	7.7	7.9	6.2	1,232	5,194	59	268	265	0	206.1	82%	96%
3/29/07 17:00	15.97	2.89	13.07	7.7	7.9	6.2	1,229	5,167	59	269	266	0	205.9	82%	96%
3/29/07 18:00	15.95	2.89	13.07	7.7	7.9	6.2	1,227	5,150	59	270	267	0	205.8	82%	96%
3/29/07 19:00	15.98	2.90	13.06	7.7	8.0	6.2	1,226	5,131	58	271	267	0	205.6	82%	96%
3/29/07 20:00	15.98	2.90	13.07	7.7	8.0	6.2	1,225	5,119	58	271	268	0	205.4	82%	96%
3/29/07 21:00	16.00	2.90	13.05	7.7	8.0	6.2	1,225	4,908	58	272	269	0	205.3	82%	96%
3/29/07 22:00	15.97	2.90	13.06	7.7	8.0	6.2	1,225	4,716	58	272	269	0	205.2	82%	96%
3/29/07 23:00	16.03	2.90	13.06	7.7	8.0	6.2	1,225	4,780	58	272	269	0	205.2	81%	96%
3/30/07 0:00	16.00	2.90	13.05	7.7	8.0	6.2	1,225	4,835	58	272	269	1	205.1	82%	96%
3/30/07 1:00	15.98	2.90	13.04	7.7	8.0	6.2	1,225	4,870	58	273	270	1	205.2	82%	96%
3/30/07 2:00	15.93	2.90	13.04	7.7	8.0	6.2	1,225	4,871	58	273	270	1	205.1	82%	96%
3/30/07 3:00	15.99	2.91	13.03	7.7	8.0	6.2	1,225	4,878	58	273	270	1	205.1	81%	96%
3/30/07 4:00	15.97	2.91	13.03	7.7	8.0	6.2	1,225	4,888	58	273	270	1	205.1	82%	96%
3/30/07 5:00	15.91	2.91	13.03	7.7	8.0	6.2	1,225	4,903	58	273	270	1	205.1	82%	96%
3/30/07 6:00	15.93	2.91	13.03	7.7	8.0	6.2	1,225	4,908	58	273	270	1	205.0	82%	96%
3/30/07 7:00	15.93	2.91	13.04	7.7	8.0	6.2	1,225	4,927	58	273	270	1	205.0	82%	96%
3/30/07 8:00	15.98	2.90	13.04	7.7	7.9	6.2	1,224	4,929	58	272	269	0	205.3	82%	96%
3/30/07 9:00	15.87	2.89	13.04	7.7	7.9	6.2	1,225	4,938	58	271	268	0	205.7	82%	96%
3/30/07 10:00	15.90	2.89	13.01	7.7	7.9	6.2	1,227	4,945	58	269	266	0	206.0	82%	96%
3/30/07 11:00	15.93	2.88	13.00	7.7	7.9	6.2	1,229	4,949	58	268	265	0	206.2	82%	96%
3/30/07 12:00	15.88	2.87	13.00	7.7	7.9	6.2	1,231	4,932	58	268	264	0	206.3	82%	96%
3/30/07 13:00	15.80	2.87	13.00	7.7	7.9	6.2	1,232	4,935	58	268	264	0	206.3	82%	96%
3/30/07 14:00	15.87	2.87	12.98	7.7	7.9	6.2	1,234	4,942	58	267	264	0	206.4	82%	96%
3/30/07 16:00	15.89	3.02	12.91	7.7	7.9	6.2	1,234	5,039	59	263	260	0	206.1	81%	96%
3/30/07 17:00	15.85	3.02	12.89	7.7	7.9	6.2	1,233	5,061	58	264	260	0	206.0	81%	96%
3/30/07 18:00	15.88	3.03	12.87	7.7	7.9	6.2	1,232	5,080	58	265	261	0	205.8	81%	96%
3/30/07 19:00	15.90	3.04	12.87	7.7	8.0	6.2	1,231	5,072	57	266	262	0	205.5	81%	96%
3/30/07 20:00	15.83	3.04	12.86	7.7	8.0	6.2	1,230	5,065	57	267	263	0	205.3	81%	96%
3/30/07 21:00	15.85	3.04	12.87	7.7	8.0	6.2	1,229	5,056	57	267	263	0	205.3	81%	96%
3/30/07 22:00	15.91	3.04	12.87	7.7	8.0	6.2	1,228	5,032	57	267	264	0	205.2	81%	96%
3/30/07 23:00	15.85	3.04	12.86	7.7	8.0	6.2	1,228	5,041	57	268	264	0	205.2	81%	96%
3/31/07 0:00	15.91	3.05	12.85	7.7	8.0	6.2	1,228	5,037	57	268	264	0	205.2	81%	96%
3/31/07 1:00	15.91	3.04	12.85	7.7	8.0	6.2	1,229	5,034	57	268	264	0	205.1	81%	96%
3/31/07 2:00	15.81	3.04	12.85	7.7	8.0	6.2	1,228	5,033	57	268	264	0	205.1	81%	96%
3/31/07 3:00	15.84	3.04	12.85	7.7	8.0	6.2	1,228	5,039	56	268	264	0	205.1	81%	96%
3/31/07 4:00	15.81	3.04	12.85	7.7	8.0	6.2	1,229	5,037	56	268	265	0	205.0	81%	96%
3/31/07 5:00	15.85	3.04	12.84	7.7	8.0	6.2	1,229	5,039	56	268	265	0	205.0	81%	96%
3/31/07 6:00	15.86	3.04	12.83	7.7	8.0	6.2	1,229	5,035	56	269	265	1	205.0	81%	96%
3/31/07 7:00	15.88	3.04	12.84	7.7	8.0	6.2	1,230	5,037	56	268	265	0	205.0	81%	96%
3/31/07 8:00	15.82	3.04	12.84	7.7	7.9	6.2	1,229	5,043	56	267	264	0	205.3	81%	96%
3/31/07 9:00	15.81	3.03	12.84	7.7	7.9	6.2	1,230	5,055	56	266	262	0	205.6	81%	96%
3/31/07 10:00	15.79	3.03	12.83	7.7	7.9	6.2	1,232	5,071	56	265	261	0	205.9	81%	96%
3/31/07 11:00	15.83	3.02	12.81	7.7	7.9	6.2	1,233	5,091	56	264	260	0	206.1	81%	96%
3/31/07 12:00	15.85	3.02	12.81	7.7	7.9	6.2	1,235	5,097	56	264	260	0	206.1	81%	96%
3/31/07 13:00	15.81	3.02	12.83	7.7	7.9	6.2	1,233	5,104	56	263	260	0	206.2	81%	96%
3/31/07 14:00	15.80	3.01	12.82	7.7	7.9	6.2	1,234	5,116	56	263	259	0	206.2	81%	96%
3/31/07 15:00	15.83	3.02	12.82	7.7	7.9	6.2	1,233	5,090	56	264	260	0	206.0	81%	96%
3/31/07 16:00	15.83	3.02	12.82	7.7	7.9	6.2	1,231	5,072	56	265	261	0	205.9	81%	96%
3/31/07 17:00	15.76	3.03	12.81	7.7	7.9	6.2	1,231	5,060	55	265	261	0	205.8	81%	96%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
3/31/07 18:00	15.80	3.03	12.80	7.7	7.9	6.2	1,230	5,061	55	266	262	0	205.7	81%	96%
3/31/07 19:00	15.78	3.03	12.79	7.7	7.9	6.2	1,229	5,032	55	266	263	0	205.6	81%	96%
3/31/07 20:00	15.70	3.04	12.79	7.7	8.0	6.2	1,228	5,023	55	267	263	0	205.4	81%	96%
3/31/07 21:00	15.83	3.04	12.78	7.7	8.0	6.2	1,228	5,021	55	267	264	0	205.2	81%	96%
3/31/07 22:00	15.81	3.04	12.77	7.7	8.0	6.2	1,228	5,017	55	268	264	0	205.3	81%	96%
3/31/07 23:00	15.87	3.04	12.78	7.7	8.0	6.2	1,228	5,019	55	268	264	0	205.2	81%	96%
4/1/07 0:00	15.86	3.04	12.77	7.7	8.0	6.2	1,229	5,025	55	268	264	0	205.3	81%	96%
4/1/07 1:00	15.84	3.04	12.77	7.7	8.0	6.2	1,230	5,024	55	268	264	0	205.2	81%	96%
4/1/07 2:00	15.78	3.04	12.77	7.7	8.0	6.2	1,229	5,015	55	268	264	0	205.2	81%	96%
4/1/07 3:00	15.84	3.04	12.76	7.7	8.0	6.2	1,228	5,012	54	269	265	0	205.1	81%	96%
4/1/07 4:00	15.77	3.04	12.77	7.7	8.0	6.2	1,227	5,010	54	269	265	0	205.1	81%	96%
4/1/07 5:00	15.78	3.04	12.76	7.7	8.0	6.2	1,228	5,007	54	269	265	0	205.1	81%	96%
4/1/07 6:00	15.78	3.05	12.76	7.7	8.0	6.2	1,228	5,000	54	269	265	0	205.0	81%	96%
4/1/07 7:00	15.84	3.04	12.77	7.7	8.0	6.2	1,228	5,006	54	269	265	0	205.0	81%	96%
4/1/07 8:00	15.75	3.04	12.78	7.7	7.9	6.2	1,226	5,009	54	268	264	0	205.3	81%	96%
4/1/07 9:00	15.78	3.04	12.77	7.7	7.9	6.2	1,227	5,024	54	267	263	0	205.5	81%	96%
4/1/07 10:00	15.74	3.03	12.76	7.7	7.9	6.2	1,228	5,040	54	266	262	0	205.8	81%	96%
4/1/07 11:00	15.75	3.02	12.75	7.7	7.9	6.2	1,230	5,051	54	265	261	0	206.0	81%	96%
4/1/07 12:00	15.76	3.02	12.74	7.7	7.9	6.2	1,231	5,068	54	264	260	0	206.1	81%	96%
4/1/07 13:00	15.70	3.02	12.74	7.7	7.9	6.2	1,233	5,075	54	264	261	0	206.1	81%	96%
4/1/07 14:00	15.71	3.02	12.75	7.7	7.9	6.2	1,232	5,072	54	265	261	0	205.9	81%	96%
4/1/07 15:00	15.71	3.02	12.75	7.7	7.9	6.2	1,231	5,069	54	265	261	0	205.9	81%	96%
4/1/07 16:00	15.73	3.03	12.73	7.7	7.9	6.2	1,231	5,058	54	266	262	0	205.8	81%	96%
4/1/07 17:00	15.80	3.03	12.75	7.7	7.9	6.2	1,229	5,039	54	266	262	0	205.6	81%	96%
4/1/07 18:00	15.72	3.04	12.72	7.7	7.9	6.2	1,228	5,028	54	267	263	0	205.5	81%	96%
4/1/07 19:00	15.68	3.04	12.72	7.7	8.0	6.2	1,227	5,013	53	268	264	0	205.4	81%	96%
4/1/07 20:00	15.74	3.04	12.72	7.7	8.0	6.2	1,226	4,995	53	268	264	0	205.3	81%	96%
4/1/07 21:00	15.76	3.05	12.71	7.7	8.0	6.2	1,226	4,987	53	268	264	0	205.3	81%	96%
4/1/07 22:00	15.70	3.05	12.71	7.7	8.0	6.2	1,227	4,980	53	268	265	0	205.2	81%	96%
4/1/07 23:00	15.73	3.05	12.71	7.7	8.0	6.2	1,226	4,966	53	269	265	0	205.1	81%	96%
4/2/07 0:00	15.66	3.05	12.71	7.7	8.0	6.2	1,226	4,961	53	269	265	0	205.1	81%	96%
4/2/07 1:00	15.69	3.05	12.71	7.7	8.0	6.2	1,226	4,963	53	269	265	0	205.1	81%	96%
4/2/07 2:00	15.72	3.05	12.70	7.7	8.0	6.2	1,227	4,978	53	269	265	0	205.1	81%	96%
4/2/07 3:00	15.74	3.05	12.69	7.7	8.0	6.2	1,229	4,985	53	269	265	0	205.1	81%	96%
4/2/07 4:00	15.71	3.05	12.70	7.7	8.0	6.2	1,227	4,971	53	269	265	0	205.1	81%	96%
4/2/07 5:00	15.67	3.05	12.69	7.7	8.0	6.2	1,226	4,961	53	270	266	0	204.9	81%	96%
4/2/07 6:00	15.69	3.05	12.68	7.7	8.0	6.2	1,226	4,960	53	270	266	0	204.9	81%	96%
4/2/07 7:00	15.68	3.05	12.70	7.7	7.9	6.2	1,227	4,967	53	269	266	0	205.0	81%	96%
4/2/07 8:00	15.74	3.05	12.71	7.7	7.9	6.2	1,225	4,972	53	269	265	0	205.2	81%	96%
4/2/07 9:00	15.77	3.04	12.70	7.7	7.9	6.2	1,226	4,988	53	267	263	0	205.5	81%	96%
4/2/07 10:00	15.67	3.04	12.69	7.7	7.9	6.2	1,227	5,003	53	266	263	0	205.7	81%	96%
4/2/07 11:00	15.65	3.03	12.69	7.7	7.9	6.2	1,229	5,013	53	266	262	0	205.9	81%	96%
4/2/07 12:00	15.68	3.03	12.66	7.7	7.9	6.2	1,230	5,023	53	265	261	0	206.0	81%	96%
4/2/07 13:00	15.64	3.02	12.66	7.7	7.9	6.2	1,232	5,044	53	265	261	0	206.1	81%	96%
4/2/07 14:00	15.66	3.02	12.67	7.7	7.9	6.2	1,232	5,045	53	264	260	0	206.2	81%	96%
4/2/07 15:00	15.61	3.02	12.65	7.7	7.9	6.2	1,233	5,045	53	264	260	0	206.2	81%	96%
4/2/07 16:00	15.64	3.02	12.65	7.7	7.9	6.2	1,233	5,044	53	265	261	0	206.1	81%	97%
4/2/07 17:00	15.65	3.03	12.64	7.7	7.9	6.2	1,230	5,026	53	266	262	0	205.9	81%	97%
4/2/07 18:00	15.65	3.04	12.63	7.7	7.9	6.2	1,228	5,012	53	267	263	0	205.7	81%	97%
4/2/07 19:00	15.61	3.04	12.63	7.7	7.9	6.2	1,227	4,991	52	268	264	0	205.4	81%	97%
4/2/07 20:00	15.58	3.04	12.63	7.7	8.0	6.2	1,225	4,983	52	268	264	0	205.3	81%	97%
4/2/07 21:00	15.60	3.05	12.63	7.7	8.0	6.2	1,225	4,976	52	269	265	0	205.2	81%	97%
4/2/07 22:00	15.62	3.05	12.63	7.7	8.0	6.2	1,225	4,972	52	269	265	0	205.2	81%	97%
4/2/07 23:00	15.62	3.05	12.62	7.7	8.0	6.2	1,225	4,966	52	269	265	0	205.1	81%	97%
4/3/07 0:00	15.61	3.05	12.61	7.7	8.0	6.2	1,225	4,960	52	269	266	0	205.0	81%	97%
4/3/07 1:00	15.63	3.05	12.62	7.7	8.0	6.2	1,225	4,959	52	270	266	0	205.0	81%	97%
4/3/07 2:00	15.62	3.05	12.62	7.7	8.0	6.2	1,226	4,964	52	270	266	0	205.0	81%	97%
4/3/07 3:00	15.64	3.05	12.61	7.7	8.0	6.2	1,225	4,956	52	270	266	0	204.9	81%	97%
4/3/07 4:00	15.67	3.05	12.60	7.7	8.0	6.2	1,225	4,954	52	270	266	0	204.9	80%	97%
4/3/07 5:00	15.60	3.05	12.60	7.7	8.0	6.2	1,226	4,952	52	270	266	0	204.9	81%	97%
4/3/07 6:00	15.64	3.05	12.60	7.7	7.9	6.2	1,227	4,959	52	270	266	0	204.9	81%	97%
4/3/07 7:00	15.64	3.05	12.61	7.7	7.9	6.2	1,226	4,957	52	270	266	0	205.0	81%	97%
4/3/07 8:00	15.71	3.05	12.62	7.7	7.9	6.2	1,224	4,957	52	269	265	0	205.2	80%	97%
4/3/07 9:00	15.60	3.04	12.62	7.7	7.9	6.2	1,225	4,971	52	268	264	0	205.5	81%	97%
4/3/07 10:00	15.57	3.04	12.59	7.7	7.9	6.2	1,227	4,983	52	267	263	0	205.8	81%	97%
4/3/07 11:00	15.59	3.03	12.59	7.7	7.9	6.2	1,228	4,987	52	266	262	0	206.0	81%	97%
4/3/07 12:00	15.52	3.03	12.58	7.7	7.9	6.2	1,230	5,005	53	265	261	0	206.0	81%	97%
4/3/07 13:00	15.57	3.02	12.58	7.7	7.9	6.2	1,232	5,009	52	265	261	0	206.1	81%	97%
4/3/07 14:00	15.62	3.02	12.58	7.7	7.9	6.2	1,233	5,008	52	264	261	0	206.2	81%	97%
4/3/07 15:00	15.57	3.03	12.57	7.7	7.9	6.2	1,232	4,997	52	265	261	0	205.9	81%	97%
4/3/07 16:00	15.54	3.03	12.57	7.7	7.9	6.2	1,228	4,978	52	266	262	0	205.8	81%	97%
4/3/07 17:00	15.56	3.04	12.57	7.7	7.9	6.2	1,228	4,964	52	267	263	0	205.6	81%	97%
4/3/07 18:00	15.58	3.04	12.55	7.7	7.9	6.2	1,226	4,949	52	268	264	0	205.5	81%	97%
4/3/07 19:00	15.59	3.05	12.55	7.7	8.0	6.2	1,225	4,938	51	269	265	0	205.3	80%	97%
4/3/07 20:00	15.62	3.05	12.54	7.7	8.0	6.2	1,224	4,923	51	269	265	0	205.2	80%	97%
4/3/07 21:00	15.62	3.05	12.53	7.7	8.0	6.2	1,224	4,916	51	269	265	0	205.1	80%	97%
4/3/07 22:00	15.63	3.05	12.54	7.7	8.0	6.2	1,224	4,912	51	270	266	0	204.9	80%	97%
4/3/07 23:00	15.65	3.05	12.54	7.7	8.0	6.2	1,224	4,909	51	270	266	0	205.0	80%	97%
4/4/07 0:00	15.57	3.06	12.54	7.7	8.0	6.2	1,224	4,903	51	270	266	0	204.9	81%	97%
4/4/07 1:00	15.54	3.05	12.53	7.7	8.0	6.2	1,225	4,902	51	270	266	0	205.0	81%	97%
4/4/07 2:00	15.54	3.05	12.53	7.7	8.0	6.2	1,226	4,909	51	270	266	0	204.9	81%	97%
4/4/07 3:00	15.55	3.05	12.54	7.7	7.9	6.2	1,227	4,916	52	270	266	0	205.0	81%	97%
4/4/07 4:00	15.58	3.05	12.53	7.7	7.9	6.2	1,226	4,912	51	270	266	0	205.1	80%	97%
4/4/07 5:00	15.57	3.06	12.53	7.7	7.9	6.2	1,226	4,912	52	270	266	0	205.0	80%	97%
4/4/07 6:00	15.62	3.05	12.53	7.7	7.9	6.2	1,226	4,915	52	270	266	0	205.1	80%	97%
4/4/07 7:00	15.61	3.05	12.53	7.7	7.9	6.2	1,227	4,918	52	270	266	0	205.1	80%	97%
4/4/07 8:00	15.48	3.05	12.54	7.7	7.9	6.2	1,224	4,915	51	269	265	0	205.2	81%	97%
4/4/07 9:00	15.59	3.05	12.53	7.7	7.9	6.2	1,224	4,938	51	268	264	0	205.5	80%	97%
4/4/07 10:00	15.60	3.04	12.52	7.7	7.9	6.2	1,226	4,958	51	267	263	0	205.7	80%	97%
4/4/07 11:00	15.55	3.04	12.51	7.7	7.9	6.2	1,227	4,963	52	267	263	0	205.8	80%	97%
4/4/07 12:00	15.49	3.03	12.50	7.7	7.9	6.2	1,227	4,972	52	266	262	0	205.9	81%	97%
4/4/07 13:00	15.52	3.03	12.50	7.7	7.9	6.2	1,230	4,981	52	265	261	0	206.1	81%	97%
4/4/07 14:00	15.50	3.03	12.48	7.7	7.9	6.2	1,232	4,983	52	266	262	0	206.0	81%	97%
4/4/07 15:00	15.51	2.99	12.55	7.7	7.9	6.2	1,231	5,013	52	268	264	0	205.9	81%	97%
4/4/07 16:00	15.54	2.85	12.78	7.7	7.9	6.2	1,227	5,200	53	276	272	0	205.7	82%	96%
4/4/07 17:00	15.61	2.86	12.77	7.7	7.9	6.2	1,226	5,190	53	276	273	0	205.6	82%	96%
4/4/07 18:00	15.62	2.86	12.77	7.7	7.9	6.2	1,226	5,180	53	277	273	0	205.5	82%	96%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
4/4/07 19:00	15.56	2.86	12.75	7.7	8.0	6.2	1,225	5,167	53	277	274	0	205.5	82%	96%
4/4/07 20:00	15.57	2.86	12.75	7.7	8.0	6.2	1,224	5,158	52	278	274	0	205.3	82%	96%
4/4/07 21:00	15.58	2.87	12.75	7.7	8.0	6.2	1,224	5,151	52	278	274	0	205.3	82%	97%
4/4/07 22:00	15.56	2.87	12.74	7.7	8.0	6.2	1,225	5,151	52	278	274	0	205.3	82%	97%
4/4/07 23:00	15.60	2.87	12.75	7.7	8.0	6.2	1,224	5,142	52	278	275	0	205.2	82%	97%
4/5/07 0:00	15.60	2.87	12.73	7.7	8.0	6.2	1,224	5,138	52	278	275	0	205.2	82%	97%
4/5/07 1:00	15.57	2.87	12.74	7.7	8.0	6.2	1,225	5,137	52	278	275	0	205.2	82%	97%
4/5/07 2:00	15.53	2.87	12.73	7.7	8.0	6.2	1,226	5,137	52	278	275	0	205.2	82%	97%
4/5/07 3:00	15.53	2.87	12.73	7.7	8.0	6.2	1,227	5,124	52	278	275	0	205.2	82%	97%
4/5/07 4:00	15.58	2.87	12.72	7.7	8.0	6.2	1,228	5,123	52	278	275	0	205.3	82%	97%
4/5/07 5:00	15.58	2.87	12.72	7.7	8.0	6.2	1,228	5,130	52	278	275	0	205.3	82%	97%
4/5/07 6:00	15.52	2.87	12.71	7.7	8.0	6.2	1,228	5,128	52	278	275	0	205.2	82%	97%
4/5/07 7:00	15.52	2.87	12.71	7.7	8.0	6.2	1,227	5,121	52	278	275	0	205.2	82%	97%
4/5/07 8:00	15.57	2.87	12.70	7.7	8.0	6.2	1,228	5,121	52	278	275	0	205.3	82%	97%
4/5/07 9:00	15.55	2.87	12.70	7.7	7.9	6.2	1,224	5,107	52	278	275	0	205.4	82%	97%
4/5/07 10:00	15.57	2.86	12.71	7.7	7.9	6.2	1,224	5,117	52	277	274	0	205.5	82%	97%
4/5/07 11:00	15.51	2.86	12.70	7.7	7.9	6.2	1,224	5,119	52	277	273	0	205.7	82%	97%
4/5/07 12:00	15.47	2.86	12.68	7.7	7.9	6.2	1,225	5,122	52	276	273	0	205.7	82%	97%
4/5/07 13:00	15.43	2.86	12.68	7.7	7.9	6.2	1,226	5,126	52	276	273	0	205.8	82%	97%
4/6/07 7:00	15.53	2.49	12.75	7.7	8.0	6.2	1,225	5,113	55	279	276	0	205.3	82%	96%
4/7/07 13:00	15.36	2.77	12.65	7.7	7.9	6.4	1,224	5,182	87	256	250	0	206.0	82%	94%
4/7/07 14:00	15.38	2.75	12.58	7.7	7.9	6.4	1,226	5,244	82	256	251	0	205.9	82%	95%
4/7/07 15:00	15.30	2.72	12.53	7.7	7.9	6.3	1,229	5,288	79	257	252	0	205.8	82%	95%
4/7/07 16:00	15.19	2.70	12.49	7.7	7.9	6.3	1,228	5,297	76	258	253	0	205.7	82%	95%
4/7/07 17:00	15.18	2.69	12.44	7.7	7.9	6.3	1,225	5,301	74	259	254	0	205.4	82%	95%
4/7/07 18:00	15.04	2.64	12.41	7.7	7.9	6.3	1,224	5,314	74	261	256	0	205.2	82%	95%
4/7/07 19:00	15.03	2.59	12.37	7.7	8.0	6.3	1,223	5,352	73	262	257	0	205.1	82%	95%
4/7/07 20:00	14.94	2.57	12.36	7.7	8.0	6.3	1,224	5,368	72	262	258	0	205.1	83%	95%
4/7/07 21:00	14.96	2.57	12.34	7.7	8.0	6.3	1,224	5,364	72	263	258	0	205.0	83%	95%
4/7/07 22:00	14.98	2.56	12.33	7.7	8.0	6.3	1,225	5,368	71	263	259	0	205.1	82%	95%
4/7/07 23:00	14.95	2.56	12.31	7.7	8.0	6.3	1,226	5,371	70	263	259	0	205.1	82%	95%
4/8/07 0:00	14.88	2.55	12.29	7.7	8.0	6.3	1,226	5,368	70	264	259	0	205.0	83%	95%
4/8/07 1:00	14.91	2.55	12.28	7.7	8.0	6.3	1,227	5,360	69	264	260	0	205.0	82%	95%
4/8/07 2:00	14.86	2.54	12.27	7.7	8.0	6.3	1,227	5,361	69	264	260	0	205.1	83%	95%
4/8/07 3:00	14.85	2.54	12.24	7.7	8.0	6.3	1,228	5,369	68	265	260	0	205.0	82%	95%
4/8/07 4:00	14.83	2.54	12.23	7.7	8.0	6.3	1,226	5,330	68	265	261	0	204.9	82%	95%
4/8/07 5:00	14.80	2.55	12.21	7.7	8.0	6.3	1,223	5,288	67	265	261	0	204.9	82%	95%
4/8/07 6:00	14.77	2.55	12.20	7.7	8.0	6.3	1,224	5,283	67	266	261	0	204.8	83%	95%
4/8/07 7:00	14.79	2.53	12.20	7.7	8.0	6.3	1,224	5,280	67	266	261	0	204.8	82%	95%
4/8/07 8:00	14.82	2.52	12.20	7.7	8.0	6.3	1,224	5,282	67	265	261	0	204.9	82%	96%
4/8/07 9:00	14.74	2.50	12.20	7.7	8.0	6.3	1,224	5,300	67	265	261	0	205.1	83%	95%
4/8/07 10:00	14.75	2.49	12.18	7.7	7.9	6.3	1,225	5,306	66	264	260	0	205.3	83%	96%
4/8/07 11:00	14.66	2.49	12.17	7.7	7.9	6.3	1,227	5,313	66	264	259	0	205.6	83%	96%
4/8/07 12:00	14.69	2.48	12.16	7.7	7.9	6.3	1,228	5,318	66	264	259	0	205.6	83%	96%
4/8/07 13:00	14.74	2.48	12.15	7.7	7.9	6.3	1,230	5,317	66	264	259	0	205.7	82%	96%
4/8/07 14:00	14.70	2.48	12.14	7.7	7.9	6.3	1,231	5,313	65	264	259	0	205.6	83%	96%
4/8/07 15:00	14.68	2.48	12.11	7.7	7.9	6.3	1,231	5,298	65	264	260	0	205.6	83%	96%
4/8/07 16:00	14.66	2.50	12.11	7.7	7.9	6.3	1,229	5,276	65	264	260	0	205.5	83%	96%
4/8/07 17:00	14.64	2.48	12.09	7.7	7.9	6.3	1,227	5,250	64	265	261	0	205.4	83%	96%
4/8/07 18:00	14.61	2.48	12.05	7.7	8.0	6.3	1,225	5,226	64	266	262	0	205.2	83%	96%
4/8/07 19:00	14.62	2.48	12.03	7.7	8.0	6.3	1,224	5,207	64	267	262	0	204.9	82%	96%
4/8/07 20:00	14.59	2.48	12.02	7.7	8.0	6.3	1,223	5,189	63	267	263	0	204.8	82%	96%
4/8/07 21:00	14.57	2.49	12.01	7.7	8.0	6.3	1,223	5,171	63	267	263	0	204.7	82%	96%
4/8/07 22:00	14.56	2.47	12.00	7.7	8.0	6.3	1,223	5,163	63	268	264	0	204.7	82%	96%
4/8/07 23:00	14.51	2.46	11.98	7.7	8.0	6.3	1,224	5,169	63	268	264	0	204.7	83%	96%
4/9/07 0:00	14.53	2.46	11.97	7.7	8.0	6.3	1,223	5,153	63	268	264	0	204.7	82%	96%
4/9/07 1:00	14.48	2.46	11.97	7.7	8.0	6.3	1,223	5,139	63	269	264	0	204.6	83%	96%
4/9/07 2:00	14.53	2.46	11.98	7.7	8.0	6.3	1,225	5,132	63	268	264	0	204.7	82%	96%
4/9/07 3:00	14.48	2.46	11.97	7.7	8.0	6.2	1,225	5,123	63	268	264	0	204.7	83%	96%
4/9/07 4:00	14.52	2.46	11.96	7.7	8.0	6.3	1,226	5,119	63	268	264	0	204.7	82%	96%
4/9/07 5:00	14.54	2.46	11.96	7.7	8.0	6.3	1,226	5,111	63	268	264	0	204.7	82%	96%
4/9/07 6:00	14.49	2.46	11.96	7.7	8.0	6.3	1,225	5,100	63	268	264	0	204.8	83%	96%
4/9/07 7:00	14.49	2.46	11.95	7.7	8.0	6.3	1,225	5,092	63	268	264	0	204.8	83%	96%
4/9/07 8:00	14.52	2.45	11.95	7.7	8.0	6.2	1,224	5,082	63	268	264	0	204.9	82%	96%
4/9/07 9:00	14.48	2.46	11.96	7.7	8.0	6.2	1,223	5,078	63	267	263	0	205.1	83%	96%
4/9/07 10:00	14.48	2.45	11.95	7.7	8.0	6.2	1,225	5,086	62	266	262	0	205.3	83%	96%
4/9/07 11:00	14.51	2.45	11.94	7.7	7.9	6.2	1,227	5,096	63	266	262	0	205.5	82%	96%
4/9/07 12:00	14.49	2.44	11.93	7.7	7.9	6.2	1,229	5,098	62	266	262	0	205.5	82%	96%
4/9/07 13:00	14.51	2.44	11.93	7.7	7.9	6.2	1,230	5,063	62	266	262	0	205.5	82%	96%
4/11/07 5:00	13.61	1.79	11.61	7.7	8.0	6.3	1,223	5,414	73	279	277	0	204.4	85%	95%
4/11/07 6:00	13.64	1.77	11.62	7.7	8.0	6.3	1,223	5,406	73	279	277	0	204.3	85%	95%
4/11/07 7:00	13.56	1.76	11.61	7.7	8.0	6.3	1,223	5,378	73	279	277	0	204.4	86%	95%
4/11/07 8:00	13.60	1.75	11.60	7.7	8.0	6.3	1,222	5,373	73	279	277	0	204.5	85%	95%
4/11/07 9:00	13.60	1.75	11.60	7.7	8.0	6.3	1,222	5,366	73	279	276	0	204.6	85%	95%
4/11/07 10:00	13.53	1.74	11.58	7.7	8.0	6.3	1,222	5,356	72	278	276	0	204.8	86%	95%
4/11/07 11:00	13.52	1.74	11.57	7.7	8.0	6.3	1,223	5,363	72	278	276	0	204.8	86%	95%
4/11/07 12:00	13.52	1.72	11.56	7.7	8.0	6.3	1,224	5,361	72	278	276	0	205.0	86%	95%
4/11/07 13:00	13.51	1.71	11.56	7.7	8.0	6.3	1,225	5,371	72	277	275	0	205.1	86%	95%
4/11/07 14:00	13.46	1.70	11.51	7.7	8.0	6.3	1,226	5,363	72	278	276	0	204.9	86%	95%
4/11/07 16:00	14.89	2.53	12.29	7.7	7.9	6.2	1,224	4,838	60	283	280	0	205.2	83%	96%
4/11/07 17:00	14.82	2.52	12.28	7.7	8.0	6.2	1,223	4,862	60	284	281	0	205.1	83%	96%
4/11/07 18:00	14.78	2.51	12.26	7.7	8.0	6.2	1,223	4,828	59	284	281	0	205.1	83%	96%
4/11/07 19:00	14.76	2.48	12.23	7.7	8.0	6.2	1,223	4,833	59	285	282	0	205.0	83%	96%
4/11/07 20:00	14.74	2.46	12.20	7.7	8.0	6.2	1,222	4,823	59	285	283	0	204.9	83%	96%
4/11/07 21:00	14.69	2.46	12.20	7.7	8.0	6.2	1,222	4,790	59	286	283	0	204.8	83%	96%
4/11/07 22:00	14.69	2.45	12.18	7.7	8.0	6.2	1,222	4,795	59	286	284	0	204.7	83%	96%
4/11/07 23:00	14.68	2.45	12.18	7.7	8.0	6.2	1,222	4,790	59	286	284	0	204.7	83%	96%
4/12/07 0:00	14.71	2.44	12.17	7.7	8.0	6.2	1,223	4,788	59	287	284	0	204.6	83%	96%
4/12/07 1:00	14.68	2.43	12.15	7.7	8.0	6.2	1,223	4,783	59	287	284	0	204.6	83%	96%
4/12/07 2:00	14.61	2.44	12.14	7.7	8.0	6.2	1,222	4,767	59	287	285	0	204.6	83%	96%
4/12/07 3:00	14.63	2.42	12.13	7.7	8.0	6.2	1,223	4,769	59	287	285	0	204.6	83%	96%
4/12/07 4:00	14.54	2.40	12.12	7.7	8.0	6.2	1,224	4,778	59	287	285	0	204.6	83%	96%
4/12/07 5:00	14.56	2.40	12.11	7.7	8.0	6.2	1,225	4,772	59	287	285	0	204.6	83%	96%
4/12/07 6:00	14.58	2.42	12.10	7.7	8.0	6.2	1,226	4,764	59	288	285	0	204.6	83%	96%
4/12/07 7:00	14.62	2.43	12.11	7.7	8.0	6.2	1,224	4,748	58	288	285	0	204.6	83%	96%
4/12/07 8:00	14.57	2.42	12.10	7.7	8.0	6.2	1,223	4,748	59	287	285	0	204.7	83%	96%
4/12/07 9:00	14.62	2.41	12.10	7.7	8.0	6.2	1,224	4,750	59	287	285	0	204.8	83%	96%

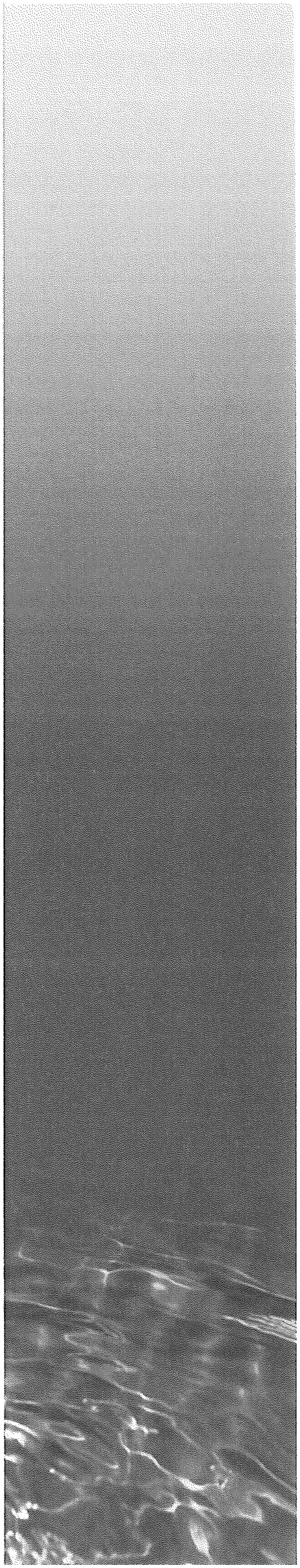
Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
4/12/07 10:00	14.52	2.39	12.10	7.7	8.0	6.2	1,224	4,765	59	287	285	0	204.9	83%	96%
4/12/07 11:00	14.56	2.39	12.11	7.7	8.0	6.2	1,225	4,772	59	287	284	0	205.0	83%	96%
4/12/07 14:00	14.79	2.32	12.36	7.7	7.9	6.2	1,225	4,870	64	285	283	0	205.3	84%	96%
4/12/07 15:00	14.69	2.28	12.31	7.7	8.0	6.2	1,226	4,920	64	286	284	0	205.4	84%	96%
4/12/07 16:00	14.69	2.26	12.27	7.7	8.0	6.2	1,227	4,906	63	287	284	0	205.3	84%	96%
4/12/07 17:00	14.61	2.24	12.25	7.7	8.0	6.2	1,226	4,904	63	287	285	0	205.2	84%	96%
4/12/07 18:00	14.51	2.20	12.20	7.7	8.0	6.2	1,224	4,923	63	289	287	0	205.1	84%	96%
4/12/07 19:00	14.47	2.18	12.16	7.7	8.0	6.2	1,223	4,901	63	290	288	0	204.9	84%	96%
4/12/07 20:00	14.39	2.17	12.14	7.7	8.0	6.2	1,222	4,894	62	290	289	0	204.8	84%	96%
4/12/07 21:00	14.41	2.16	12.12	7.7	8.0	6.2	1,222	4,894	62	291	289	0	204.6	84%	96%
4/12/07 22:00	14.32	2.13	12.10	7.7	8.0	6.2	1,222	4,902	63	292	290	0	204.6	84%	96%
4/12/07 23:00	14.32	2.12	12.07	7.7	8.0	6.2	1,222	4,896	62	292	290	0	204.5	84%	96%
4/13/07 0:00	14.21	2.11	12.05	7.7	8.0	6.2	1,221	4,862	62	293	291	0	204.5	85%	96%
4/13/07 1:00	14.24	2.09	12.02	7.7	8.0	6.2	1,221	4,861	62	293	292	0	204.4	84%	96%
4/13/07 2:00	14.15	2.08	12.01	7.7	8.0	6.2	1,221	4,864	62	294	292	0	204.3	85%	96%
4/13/07 3:00	14.22	2.07	11.99	7.7	8.0	6.2	1,221	4,857	62	294	293	0	204.3	84%	96%
4/13/07 4:00	14.13	2.06	11.97	7.7	8.0	6.2	1,222	4,848	62	294	293	0	204.3	85%	96%
4/13/07 5:00	14.14	2.06	11.96	7.7	8.0	6.2	1,223	4,839	62	294	293	0	204.3	85%	96%
4/13/07 6:00	14.16	2.06	11.95	7.7	8.0	6.2	1,224	4,829	62	295	293	0	204.3	84%	96%
4/13/07 7:00	14.14	2.05	11.94	7.7	8.0	6.2	1,223	4,827	62	294	293	0	204.3	84%	96%
4/13/07 8:00	14.13	2.04	11.95	7.7	8.0	6.2	1,221	4,830	62	294	292	0	204.6	85%	96%
4/13/07 9:00	14.11	2.03	11.95	7.7	8.0	6.2	1,223	4,834	62	293	291	0	204.9	85%	96%
4/13/07 10:00	14.07	2.02	11.94	7.7	8.0	6.2	1,225	4,849	62	292	290	0	205.2	85%	96%
4/13/07 11:00	14.09	2.01	11.94	7.7	8.0	6.2	1,225	4,868	62	291	290	0	205.4	85%	96%
4/13/07 12:00	14.11	2.00	11.93	7.7	8.0	6.2	1,226	4,880	62	291	289	0	202.0	85%	96%
4/13/07 13:00	13.07	1.61	11.04	7.7	8.0	6.3	1,227	4,892	68	273	271	0	205.3	85%	95%
4/13/07 14:00	12.78	1.52	10.92	7.7	8.0	6.3	1,227	4,952	70	272	270	0	205.1	85%	95%
4/13/07 15:00	12.75	1.51	10.88	7.7	8.0	6.3	1,225	4,943	70	273	271	0	204.8	85%	95%
4/13/07 16:00	12.77	1.51	10.86	7.7	8.0	6.3	1,225	4,920	70	274	272	0	204.9	85%	95%
4/13/07 17:00	12.74	1.51	10.84	7.7	8.0	6.3	1,225	4,898	70	274	272	0	204.8	85%	95%
4/13/07 18:00	12.72	1.52	10.80	7.7	8.0	6.3	1,222	4,874	69	275	273	0	204.6	85%	95%
4/13/07 19:00	12.65	1.52	10.78	7.7	8.0	6.3	1,221	4,860	69	276	274	0	204.3	85%	95%
4/13/07 20:00	12.67	1.52	10.76	7.7	8.0	6.3	1,219	4,832	69	277	275	0	204.2	85%	95%
4/13/07 21:00	12.61	1.51	10.74	7.7	8.0	6.3	1,220	4,840	69	277	275	0	204.1	85%	95%
4/13/07 22:00	12.61	1.51	10.73	7.7	8.0	6.3	1,220	4,816	69	277	276	0	204.2	85%	95%
4/13/07 23:00	12.69	1.50	10.71	7.7	8.0	6.3	1,220	4,792	69	278	276	0	204.1	84%	95%
4/14/07 0:00	12.59	1.51	10.70	7.7	8.0	6.3	1,220	4,783	68	278	276	0	204.0	85%	95%
4/14/07 1:00	12.59	1.52	10.69	7.7	8.0	6.3	1,219	4,779	68	278	276	0	204.0	85%	95%
4/14/07 2:00	12.58	1.51	10.68	7.7	8.0	6.3	1,220	4,782	68	278	277	0	204.0	85%	95%
4/14/07 3:00	12.51	1.50	10.67	7.7	8.0	6.3	1,221	4,759	68	279	277	0	204.1	85%	95%
4/14/07 4:00	12.52	1.50	10.66	7.7	8.0	6.3	1,222	4,748	68	279	277	0	204.1	85%	95%
4/14/07 5:00	12.54	1.50	10.66	7.7	8.0	6.3	1,222	4,735	68	279	277	0	204.1	85%	95%
4/14/07 6:00	12.52	1.51	10.66	7.7	8.0	6.3	1,220	4,720	68	278	277	0	204.1	85%	95%
4/14/07 7:00	12.55	1.51	10.64	7.7	8.0	6.3	1,221	4,727	68	279	277	0	204.2	85%	95%
4/14/07 11:00	13.99	2.06	11.81	7.7	8.0	6.3	1,222	4,741	67	289	287	0	204.8	84%	95%
4/14/07 12:00	13.91	2.02	11.74	7.7	8.0	6.3	1,221	4,726	66	291	289	0	204.6	84%	95%
4/14/07 13:00	13.82	2.00	11.71	7.7	8.0	6.2	1,221	4,731	66	291	289	0	204.7	85%	95%
4/14/07 14:00	13.84	1.99	11.70	7.7	8.0	6.2	1,221	4,723	65	291	289	0	204.8	85%	95%
4/14/07 15:00	13.79	1.98	11.67	7.7	8.0	6.2	1,221	4,730	65	291	289	0	204.9	85%	96%
4/14/07 16:00	13.73	1.97	11.64	7.7	8.0	6.2	1,222	4,714	64	291	290	0	204.9	85%	96%
4/14/07 17:00	13.73	1.97	11.61	7.7	8.0	6.2	1,223	4,696	64	292	290	0	204.8	85%	96%
4/14/07 18:00	13.73	1.97	11.57	7.7	8.0	6.2	1,221	4,674	64	293	291	0	204.7	84%	96%
4/14/07 19:00	13.69	1.97	11.55	7.7	8.0	6.2	1,221	4,642	63	293	292	0	204.6	84%	96%
4/14/07 20:00	13.59	1.96	11.53	7.7	8.0	6.2	1,220	4,646	63	294	292	0	204.5	85%	96%
4/14/07 21:00	13.63	1.94	11.52	7.7	8.0	6.2	1,220	4,631	63	294	292	0	204.6	85%	96%
4/14/07 22:00	13.59	1.93	11.50	7.7	8.0	6.2	1,221	4,640	63	294	293	0	204.5	85%	96%
4/14/07 23:00	13.50	1.94	11.48	7.7	8.0	6.2	1,222	4,640	63	294	293	0	204.5	85%	96%
4/15/07 0:00	13.51	1.93	11.46	7.7	8.0	6.2	1,222	4,632	63	295	293	0	204.6	85%	96%
4/15/07 1:00	13.52	1.93	11.44	7.7	8.0	6.2	1,223	4,618	63	295	294	0	204.5	85%	96%
4/15/07 2:00	13.55	1.92	11.43	7.7	8.0	6.2	1,221	4,596	63	295	294	0	204.5	84%	96%
4/15/07 3:00	13.54	1.93	11.41	7.7	8.0	6.2	1,222	4,567	63	295	294	0	204.5	84%	96%
4/15/07 4:00	13.53	1.93	11.40	7.7	8.0	6.2	1,221	4,575	62	295	294	0	204.4	84%	96%
4/15/07 5:00	13.45	1.92	11.38	7.7	8.0	6.2	1,221	4,574	62	296	294	0	204.5	85%	96%
4/15/07 6:00	13.38	1.92	11.36	7.7	8.0	6.2	1,220	4,566	62	296	295	0	204.4	85%	96%
4/15/07 7:00	13.46	1.92	11.36	7.7	8.0	6.2	1,220	4,563	62	296	295	0	204.4	84%	96%
4/15/07 8:00	13.48	1.91	11.36	7.7	8.0	6.2	1,220	4,561	62	295	294	0	204.6	84%	96%
4/15/07 9:00	13.41	1.91	11.35	7.7	8.0	6.2	1,220	4,560	62	295	294	0	204.7	85%	96%
4/15/07 10:00	13.42	1.90	11.34	7.7	8.0	6.2	1,221	4,535	62	295	293	0	204.9	85%	96%
4/15/07 11:00	13.38	1.89	11.32	7.7	8.0	6.2	1,222	4,528	62	294	293	0	205.0	85%	96%
4/15/07 12:00	13.32	1.88	11.31	7.7	8.0	6.2	1,223	4,561	62	294	292	0	205.1	85%	96%
4/15/07 13:00	13.33	1.87	11.30	7.7	8.0	6.2	1,224	4,547	62	294	292	0	205.2	85%	96%
4/15/07 14:00	13.33	1.87	11.28	7.7	8.0	6.2	1,223	4,533	62	294	293	0	205.0	85%	96%
4/15/07 15:00	13.28	1.86	11.28	7.7	8.0	6.2	1,224	4,536	62	294	293	0	205.1	85%	96%
4/15/07 16:00	13.27	1.86	11.26	7.7	8.0	6.2	1,225	4,511	62	294	293	0	205.2	85%	96%
4/15/07 17:00	13.32	1.86	11.22	7.7	8.0	6.2	1,226	4,502	62	294	293	0	205.0	84%	96%
4/15/07 18:00	13.30	1.87	11.20	7.7	8.0	6.2	1,223	4,466	62	295	294	0	204.9	84%	96%
4/15/07 19:00	13.21	1.88	11.16	7.7	8.0	6.2	1,220	4,465	61	296	295	0	204.6	85%	96%
4/15/07 20:00	13.22	1.87	11.13	7.7	8.0	6.2	1,219	4,434	61	297	296	0	204.5	84%	96%
4/15/07 21:00	13.22	1.87	11.12	7.7	8.0	6.2	1,218	4,420	61	297	296	0	204.4	84%	96%
4/15/07 22:00	13.15	1.87	11.10	7.7	8.0	6.2	1,219	4,423	61	298	296	0	204.3	84%	96%
4/15/07 23:00	13.16	1.86	11.09	7.7	8.0	6.2	1,219	4,421	61	298	297	0	204.3	84%	96%
4/16/07 0:00	13.14	1.87	11.07	7.7	8.0	6.2	1,219	4,407	61	298	297	0	204.2	84%	96%
4/16/07 1:00	13.05	1.85	11.05	7.7	8.0	6.2	1,219	4,403	61	299	298	0	204.2	85%	96%
4/16/07 2:00	13.05	1.86	11.04	7.7	8.0	6.2	1,219	4,394	61	299	298	0	204.2	85%	96%
4/16/07 3:00	13.12	1.86	11.02	7.7	8.0	6.2	1,219	4,384	60	299	298	0	204.1	84%	96%
4/16/07 4:00	13.14	1.87	11.01	7.7	8.0	6.2	1,219	4,344	60	299	298	0	204.1	84%	96%
4/16/07 5:00	13.06	1.87	11.00	7.7	8.0	6.2	1,219	4,361	60	300	298	0	204.1	84%	96%
4/18/07 14:00	14.93	2.11	12.86	7.7	7.9	6.5	1,219	6,566	125	233	224	0	205.4	86%	91%
4/18/07 15:00	14.70	1.97	12.75	7.7	7.9	6.5	1,219	7,999	121	235	226	0	205.4	87%	91%
4/18/07 16:00	14.61	1.83	12.67	7.7	8.0	6.5	1,221	7,998	119	237	229	0	205.3	87%	92%
4/18/07 17:00	14.48	1.72	12.61	7.7	8.0	6.5	1,220	7,999	116	239	231	0	205.1	87%	92%
4/18/07 18:00	14.32	1.64	12.54	7.7	8.0	6.5	1,219	7,999	114	240	233	0	205.0	88%	92%
4/18/07 19:00	14.30	1.58	12.47	7.7	8.0	6.5	1,218	8,000	112	242	235	0	204.8	87%	92%
4/18/07 20:00	14.19	1.52	12.42	7.7	8.0	6.5	1,217	8,000	111	243	236	0	204.7	88%	92%
4/18/07 21:00	13.98	1.31	12.37	7.7	8.0	6.5	1,217	8,000	113	246	240	0	204.5	89%	92%
4/18/07 22:00	13.40	0.97	12.14	7.7	8.0	6.5	1,217	8,000	125	253	248	0	204.3	91%	91%
4/18/07 23:00	13.18	0.94	12.01	7.7	8.0	6.5	1,217	8,000	128	256	251	0	204.2	91%	90%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
4/19/07 0:00	13.16	0.94	11.94	7.7	8.0	6.5	1,217	8,000	126	257	252	0	204.1	91%	91%
4/19/07 1:00	13.04	0.94	11.88	7.7	8.0	6.5	1,217	8,000	124	258	253	0	204.0	91%	91%
4/19/07 2:00	13.04	0.74	11.83	7.7	8.0	6.5	1,218	8,000	123	259	254	0	204.0	91%	91%
4/19/07 3:00	12.97	0.19	11.77	7.7	8.0	6.5	1,217	8,000	122	260	255	0	204.0	91%	91%
4/19/07 4:00	12.90	0.16	11.72	7.7	8.0	6.5	1,218	8,000	121	261	256	0	203.9	91%	91%
4/19/07 5:00	12.72	0.21	11.64	7.7	8.0	6.5	1,219	8,000	122	262	258	0	203.9	92%	91%
4/19/07 6:00	12.64	0.14	11.56	7.7	8.0	6.5	1,220	8,000	124	263	259	0	203.9	91%	91%
4/19/07 7:00	12.54	0.05	11.47	7.7	8.0	6.5	1,219	8,000	126	265	261	0	203.9	92%	91%
4/19/07 8:00	12.45	0.05	11.41	7.7	8.0	6.5	1,216	8,000	125	265	261	0	204.0	92%	91%
4/19/07 9:00	12.47	0.15	11.36	7.7	8.0	6.5	1,217	8,000	124	264	260	0	204.2	91%	91%
4/19/07 10:00	16.82	2.97	13.92	7.7	7.9	6.2	1,220	5,540	61	267	260	0	205.9	83%	96%
4/19/07 11:00	16.82	2.81	14.06	7.7	7.9	6.2	1,221	5,468	61	267	260	0	206.0	84%	96%
4/19/07 12:00	16.82	2.79	14.08	7.7	7.9	6.2	1,222	5,501	62	267	260	0	206.0	84%	96%
4/19/07 13:00	16.79	2.80	14.08	7.7	7.9	6.2	1,222	5,487	63	266	260	0	206.0	84%	96%
4/19/07 14:00	16.83	2.80	14.08	7.7	7.9	6.2	1,223	5,484	63	266	260	0	206.1	84%	96%
4/19/07 15:00	16.77	2.81	14.08	7.7	7.9	6.2	1,223	5,456	63	266	260	0	206.1	84%	96%
4/19/07 16:00	16.83	2.81	14.07	7.7	7.9	6.2	1,224	5,443	63	266	260	0	206.0	84%	96%
4/19/07 17:00	16.84	2.82	14.06	7.7	7.9	6.2	1,221	5,409	62	267	260	0	205.9	84%	96%
4/19/07 18:00	16.80	2.83	14.06	7.7	7.9	6.2	1,221	5,385	62	267	261	0	205.9	84%	96%
4/19/07 19:00	16.77	2.83	14.03	7.7	8.0	6.2	1,220	5,351	62	267	261	1	205.9	84%	96%
4/19/07 20:00	16.81	2.83	14.01	7.7	8.0	6.2	1,219	5,327	61	268	262	1	205.7	83%	96%
4/19/07 21:00	16.73	2.82	14.00	7.7	8.0	6.2	1,218	5,314	61	268	262	1	205.6	84%	96%
4/19/07 22:00	16.74	2.83	14.00	7.7	8.0	6.2	1,219	5,305	61	268	262	1	205.6	84%	96%
4/19/07 23:00	16.78	2.83	14.00	7.7	7.9	6.2	1,221	5,297	61	268	262	1	205.7	83%	96%
4/20/07 0:00	16.74	2.84	13.98	7.7	7.9	6.2	1,221	5,275	61	268	262	1	205.7	84%	96%
4/20/07 1:00	16.72	2.85	13.97	7.7	7.9	6.2	1,221	5,251	60	268	262	1	205.7	84%	96%
4/20/07 2:00	16.68	2.85	13.96	7.7	7.9	6.2	1,221	5,244	60	268	262	1	205.7	84%	96%
4/20/07 3:00	16.70	2.84	13.96	7.7	7.9	6.2	1,222	5,232	60	268	262	1	205.7	84%	96%
4/20/07 4:00	16.72	2.85	13.95	7.7	7.9	6.2	1,222	5,219	60	268	262	1	205.7	83%	96%
4/20/07 5:00	16.67	2.85	13.95	7.7	7.9	6.2	1,223	5,206	60	268	262	1	205.7	84%	96%
4/20/07 6:00	16.69	2.85	13.93	7.7	7.9	6.2	1,224	5,194	60	268	262	1	205.7	84%	96%
4/20/07 7:00	16.69	2.84	13.93	7.7	7.9	6.2	1,224	5,188	59	269	263	0	205.7	83%	96%
4/20/07 8:00	16.65	2.84	13.93	7.7	7.9	6.2	1,222	5,170	59	269	263	0	205.8	84%	96%
4/20/07 9:00	16.64	2.84	13.92	7.7	7.9	6.2	1,220	5,155	59	268	262	0	205.9	84%	96%
4/20/07 10:00	16.72	3.05	13.75	7.7	7.9	6.2	1,221	5,125	59	265	259	0	206.1	82%	96%
4/20/07 14:00	16.22	2.86	13.53	7.7	7.9	6.5	1,219	5,358	107	251	242	0	206.3	83%	93%
4/20/07 15:00	16.31	2.88	13.45	7.7	7.9	6.4	1,222	5,339	102	250.83	242	0	206.1	82.53%	93%
4/20/07 16:00	16.25	2.88	13.44	7.7	7.9	6.4	1,222	5,339	98	251.32	243	0	205.9	83%	93%
4/20/07 17:00	16.32	2.88	13.43	7.7	7.9	6.4	1,223	5,352	96	251.26	243	0	206.0	82%	94%
4/20/07 18:00	16.25	2.89	13.41	7.7	7.9	6.4	1,223	5,339	93	251.44	243	0	205.9	83%	94%
4/20/07 19:00	16.18	2.91	13.38	7.7	7.9	6.4	1,220	5,290	91	252.01	244	0	205.7	83%	94%
4/20/07 20:00	16.21	2.91	13.38	7.7	7.9	6.4	1,220	5,282	89	252.34	244	0	205.6	83%	94%
4/20/07 21:00	16.19	2.91	13.37	7.7	7.9	6.4	1,221	5,275	88	252.35	244	0	205.6	83%	94%
4/20/07 22:00	16.19	2.92	13.36	7.7	7.9	6.4	1,220	5,251	86	252.71	244	0	205.5	83%	94%
4/20/07 23:00	16.19	2.92	13.34	7.7	7.9	6.4	1,219	5,242	85	252.91	245	0	205.4	82%	94%
4/21/07 0:00	16.17	2.93	13.33	7.7	7.9	6.4	1,220	5,223	84	253.11	245	0	205.4	82%	94%
4/21/07 1:00	16.21	2.93	13.32	7.7	7.9	6.4	1,220	5,212	83	253.29	245	0	205.3	82%	94%
4/21/07 2:00	16.12	2.92	13.31	7.7	7.9	6.4	1,219	5,216	82	253.51	245	1	205.3	83%	94%
4/21/07 3:00	16.16	2.92	13.30	7.7	7.9	6.4	1,220	5,211	81	253.57	245	1	205.2	82%	95%
4/21/07 4:00	16.17	2.93	13.29	7.7	7.9	6.4	1,220	5,189	80	253.61	245	1	205.2	82%	95%
4/21/07 5:00	16.11	2.93	13.29	7.7	7.9	6.4	1,220	5,176	79	253.86	246	1	205.2	83%	95%
4/21/07 6:00	16.17	2.93	13.29	7.7	7.9	6.3	1,220	5,169	78	253.94	246	1	205.1	82%	95%
4/21/07 7:00	16.16	2.93	13.30	7.7	7.9	6.3	1,219	5,165	78	253.42	245	0	205.3	82%	95%
4/21/07 8:00	16.13	2.92	13.31	7.7	7.9	6.3	1,219	5,155	77	252.70	244	0	205.5	83%	95%
4/21/07 9:00	16.18	2.92	13.31	7.7	7.9	6.3	1,221	5,175	77	252.01	244	0	205.8	82%	95%
4/21/07 10:00	16.11	2.92	13.31	7.7	7.9	6.3	1,222	5,170	77	251.62	243	0	205.9	83%	95%
4/21/07 11:00	16.09	2.92	13.30	7.7	7.9	6.3	1,223	5,168	76	251.44	243	0	206.0	83%	95%
4/21/07 12:00	16.17	2.92	13.30	7.7	7.9	6.3	1,224	5,166	76	251.24	243	0	206.0	82%	95%
4/21/07 13:00	16.12	2.92	13.29	7.7	7.9	6.3	1,225	5,159	75	251.70	243	0	205.9	82%	95%
4/21/07 14:00	16.15	2.92	13.29	7.7	7.9	6.3	1,224	5,152	75	251.72	243	0	205.9	82%	95%
4/21/07 15:00	16.14	2.92	13.27	7.7	7.9	6.3	1,225	5,142	74	251.81	243	0	205.9	82%	95%
4/21/07 16:00	16.16	2.93	13.25	7.7	7.9	6.3	1,222	5,111	73	252.22	244	0	205.8	82%	95%
4/21/07 17:00	16.16	2.93	13.26	7.7	7.9	6.3	1,222	5,095	73	252.37	244	0	205.7	82%	95%
4/21/07 18:00	16.13	2.93	13.24	7.7	7.9	6.3	1,221	5,078	72	252.72	244	0	205.6	82%	95%
4/21/07 19:00	16.10	2.93	13.23	7.7	8.0	6.3	1,220	5,067	72	253.09	245	0	205.5	82%	95%
4/21/07 20:00	16.06	2.93	13.23	7.7	7.9	6.3	1,221	5,061	72	253.16	245	0	205.5	82%	95%
4/21/07 21:00	16.14	2.93	13.23	7.7	7.9	6.3	1,222	5,044	71	253.19	245	0	205.5	82%	95%
4/21/07 22:00	16.10	2.93	13.22	7.7	7.9	6.3	1,222	5,017	71	253.22	245	0	205.5	82%	95%
4/21/07 23:00	16.06	2.93	13.22	7.7	7.9	6.3	1,223	5,030	71	253.26	245	0	205.5	82%	95%
4/22/07 0:00	16.11	2.93	13.21	7.7	7.9	6.3	1,223	5,012	70	253.29	245	0	205.5	82%	95%
4/22/07 1:00	16.12	2.93	13.21	7.7	7.9	6.3	1,223	5,004	70	253.36	245	0	205.6	82%	95%
4/22/07 2:00	16.06	2.93	13.19	7.7	7.9	6.3	1,224	4,997	70	253.43	245	0	205.5	82%	95%
4/22/07 3:00	16.06	2.94	13.19	7.7	7.9	6.3	1,224	4,969	69	253.36	245	0	205.6	82%	95%
4/22/07 4:00	16.05	2.94	13.17	7.7	7.9	6.3	1,221	4,947	69	253.61	245	0	205.5	82%	95%
4/22/07 5:00	16.00	2.94	13.18	7.7	7.9	6.3	1,222	4,949	69	253.50	245	0	205.6	82%	95%
4/22/07 6:00	16.06	2.94	13.18	7.7	7.9	6.3	1,223	4,925	68	253.57	245	0	205.5	82%	95%
4/22/07 7:00	16.11	2.94	13.18	7.7	7.9	6.3	1,224	4,923	68	253.52	245	0	205.5	82%	95%
4/22/07 8:00	16.05	2.94	13.19	7.7	7.9	6.3	1,223	4,916	68	253.20	245	0	205.6	82%	95%
4/22/07 9:00	16.10	2.94	13.19	7.7	7.9	6.3	1,221	4,900	68	252.80	244	0	205.7	82%	95%
4/22/07 10:00	16.00	2.94	13.19	7.7	7.9	6.3	1,222	4,911	67	252.68	244	0	205.8	82%	95%
4/22/07 11:00	16.09	2.94	13.19	7.7	7.9	6.3	1,223	4,908	67	252.78	244	0	205.7	82%	95%
4/22/07 12:00	16.05	2.94	13.19	7.7	7.9	6.3	1,223	4,899	67	252.02	244	0	206.0	82%	95%
4/22/07 13:00	16.08	2.94	13.16	7.7	7.9	6.3	1,223	4,866	67	252.63	244	0	205.8	82%	96%
4/22/07 14:00	16.05	2.95	13.17	7.7	7.9	6.3	1,223	4,851	66	252.85	245	0	205.7	82%	96%
4/22/07 15:00	16.06	2.95	13.16	7.7	7.9	6.3	1,222	4,831	66	253.10	245	0	205.7	82%	96%
4/22/07 16:00	16.04	2.95	13.15	7.7	7.9	6.3	1,222	4,838	66	253.13	245	0	205.7	82%	96%
4/22/07 17:00	16.14	2.95	13.15	7.7	7.9	6.3	1,223	4,818	66	253.10	245	0	205.7	81%	96%
4/22/07 18:00	16.04	2.95	13.14	7.7	7.9	6.3	1,224	4,810	65	253.19	245	0	205.7	82%	96%
4/22/07 19:00	16.08	2.95	13.13	7.7	7.9	6.3	1,222	4,805	65	253.47	245	0	205.5	82%	96%
4/22/07 20:00	15.99	2.95	13.12	7.7	7.9	6.3	1,221	4,780	65	253.75	245	0	205.5	82%	96%
4/22/07 21:00	16.05	2.96	13.11	7.7	7.9	6.3	1,221	4,767	65	254.01	246	0	205.4	82%	96%
4/22/07 22:00	16.02	2.96	13.11	7.7	7.9	6.3	1,220	4,761	64	254.28	246	0	205.3	82%	96%
4/22/07 23:00	16.02	2.96	13.11	7.7	7.9	6.3	1,220	4,747	64	254.34	246	0	205.3	82%	96%
4/23/07 0:00	16.03	2.96	13.11	7.7	7.9	6.3	1,220	4,744	64	254.46	246	0	205.2	82%	96%
4/23/07 1:00	16.06	2.96	13.10	7.7	7.9	6.3	1,221	4,718	64	254.51	246	0	205.2	82%	96%
4/23/07 2:00	15.97	2.96	13.11	7.7	7.9	6.3	1,222	4,749	64	254.31	246	0	205.3	82%	96%
4/23/07 3:00	15.99	2.96	13.11	7.7	7.9	6.3	1,222	4,699	64	254.26	246	0	205.4	82%	96%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
4/23/07 4:00	15.96	2.96	13.09	7.7	7.9	6.3	1,222	4,684	63	254.25	246	0	205.3	82%	96%
4/23/07 5:00	15.98	2.96	13.08	7.7	7.9	6.3	1,223	4,676	63	254.40	246	0	205.3	82%	96%
4/23/07 6:00	15.98	2.96	13.07	7.7	7.9	6.3	1,222	4,659	63	254.74	247	0	205.2	82%	96%
4/23/07 7:00	15.91	2.96	13.10	7.7	7.9	6.3	1,222	4,660	63	254.51	246	0	205.2	82%	96%
4/23/07 8:00	16.07	2.96	13.11	7.7	7.9	6.2	1,220	4,657	63	253.61	245	0	205.5	82%	96%
4/23/07 9:00	15.95	2.95	13.10	7.7	7.9	6.2	1,222	4,677	63	252.82	245	0	205.8	82%	96%
4/23/07 10:00	16.01	2.95	13.12	7.7	7.9	6.2	1,223	4,694	63	252.29	244	0	206.0	82%	96%
4/23/07 11:00	15.93	2.95	13.11	7.7	7.9	6.2	1,225	4,715	63	251.86	244	0	206.1	82%	96%
4/23/07 12:00	16.06	2.95	13.12	7.7	7.9	6.2	1,226	4,718	63	251.56	243	0	206.2	82%	96%
4/23/07 13:00	15.95	2.94	13.11	7.7	7.9	6.2	1,227	4,704	63	251.26	243	0	206.2	82%	96%
4/23/07 14:00	16.00	2.94	13.12	7.7	7.9	6.2	1,228	4,714	63	251.18	243	0	206.3	82%	96%
4/23/07 15:00	15.97	2.95	13.11	7.7	7.9	6.2	1,226	4,677	62	251.93	244	0	206.0	82%	96%
4/23/07 16:00	16.01	2.95	13.11	7.7	7.9	6.2	1,225	4,675	62	252.02	244	0	206.0	82%	96%
4/23/07 17:00	15.95	2.95	13.09	7.7	7.9	6.2	1,224	4,667	62	252.45	244	0	205.9	82%	96%
4/23/07 18:00	15.98	2.95	13.09	7.7	7.9	6.2	1,223	4,653	62	252.90	245	0	205.7	82%	96%
4/23/07 19:00	15.96	2.96	13.06	7.7	7.9	6.2	1,222	4,617	61	253.57	245	0	205.6	82%	96%
4/23/07 20:00	15.96	2.96	13.06	7.7	8.0	6.2	1,221	4,615	61	253.94	246	0	205.5	82%	96%
4/23/07 21:00	15.92	2.96	13.04	7.7	8.0	6.2	1,221	4,582	61	254.18	246	0	205.4	82%	96%
4/23/07 22:00	15.95	2.97	13.04	7.7	8.0	6.2	1,221	4,586	61	254.37	246	0	205.3	82%	96%
4/23/07 23:00	15.96	2.96	13.03	7.7	8.0	6.2	1,220	4,566	61	254.54	246	0	205.3	82%	96%
4/24/07 0:00	15.99	2.97	13.03	7.7	8.0	6.2	1,221	4,570	61	254.69	246	0	205.2	82%	96%
4/24/07 1:00	15.98	2.97	13.02	7.7	7.9	6.2	1,221	4,545	60	254.76	247	0	205.2	82%	96%
4/24/07 2:00	15.91	2.97	13.02	7.7	8.0	6.2	1,221	4,543	60	254.98	247	0	205.2	82%	96%
4/24/07 3:00	15.94	2.97	13.00	7.7	7.9	6.2	1,220	4,526	60	255.15	247	0	205.1	82%	96%
4/24/07 4:00	15.87	2.97	13.01	7.7	7.9	6.2	1,221	4,529	60	255.32	247	0	205.1	82%	96%
4/24/07 5:00	15.88	2.97	12.99	7.7	7.9	6.2	1,221	4,518	60	255.45	247	0	205.0	82%	96%
4/24/07 6:00	15.88	2.97	12.99	7.7	7.9	6.2	1,221	4,484	60	255.53	247	1	205.0	82%	96%
4/24/07 7:00	15.90	2.97	13.01	7.7	7.9	6.2	1,221	4,505	60	254.92	247	0	205.1	82%	96%
4/24/07 8:00	15.94	2.96	13.01	7.7	7.9	6.2	1,222	4,521	60	253.95	246	0	205.4	82%	96%
4/24/07 9:00	15.91	2.96	13.00	7.7	7.9	6.2	1,223	4,530	60	253.07	245	0	205.7	82%	96%
4/24/07 10:00	15.89	2.95	13.00	7.7	7.9	6.2	1,225	4,540	60	252.37	244	0	205.9	82%	96%
4/24/07 11:00	15.89	2.95	13.01	7.7	7.9	6.2	1,226	4,546	60	251.81	244	0	206.1	82%	96%
4/24/07 12:00	15.90	2.95	13.02	7.7	7.9	6.2	1,227	4,523	60	251.40	243	0	206.2	82%	96%
4/24/07 13:00	15.87	2.94	13.02	7.7	7.9	6.2	1,228	4,541	60	251.12	243	0	206.3	82%	96%
4/24/07 14:00	15.91	2.94	13.01	7.7	7.9	6.2	1,230	4,531	60	251.32	243	0	206.2	82%	96%
4/24/07 15:00	15.93	2.94	13.02	7.7	7.9	6.2	1,227	4,515	60	251.66	243	0	206.1	82%	96%
4/24/07 16:00	15.90	2.95	13.01	7.7	7.9	6.2	1,226	4,498	60	252.01	244	0	206.0	82%	96%
4/24/07 17:00	15.90	2.95	13.00	7.7	7.9	6.2	1,226	4,489	60	252.19	244	0	206.0	82%	96%
4/24/07 18:00	15.90	2.95	12.98	7.7	7.9	6.2	1,224	4,476	59	252.69	244	0	205.8	82%	96%
4/24/07 19:00	15.92	2.96	12.96	7.7	7.9	6.2	1,223	4,434	59	253.38	245	0	205.7	81%	96%
4/24/07 20:00	15.88	2.96	12.95	7.7	8.0	6.2	1,222	4,441	59	253.86	246	0	205.5	82%	96%
4/24/07 21:00	15.85	2.96	12.94	7.7	8.0	6.2	1,221	4,426	59	254.14	246	0	205.4	82%	96%
4/24/07 22:00	15.89	2.96	12.93	7.7	8.0	6.2	1,221	4,413	58	254.42	246	0	205.3	81%	96%
4/24/07 23:00	15.85	2.97	12.93	7.7	8.0	6.2	1,221	4,404	58	254.64	246	0	205.3	82%	96%
4/25/07 0:00	15.80	2.97	12.93	7.7	8.0	6.2	1,221	4,359	58	254.85	247	0	205.2	82%	96%
4/25/07 1:00	15.81	2.97	12.92	7.7	8.0	6.2	1,221	4,351	58	254.98	247	0	205.2	82%	96%
4/25/07 2:00	15.82	2.97	12.91	7.7	8.0	6.2	1,221	4,373	58	255.13	247	0	205.1	82%	96%
4/25/07 3:00	15.89	2.97	12.92	7.7	7.9	6.2	1,221	4,347	58	255.24	247	0	205.1	81%	96%
4/25/07 4:00	15.81	2.97	12.90	7.7	7.9	6.2	1,222	4,350	58	255.30	247	0	205.1	82%	96%
4/25/07 5:00	15.81	2.97	12.90	7.7	7.9	6.2	1,221	4,349	58	255.41	247	0	205.1	82%	96%
4/25/07 6:00	15.84	2.97	12.90	7.7	7.9	6.2	1,222	4,334	58	255.42	247	0	205.1	81%	96%
4/25/07 7:00	15.85	2.97	12.91	7.7	7.9	6.2	1,221	4,342	58	254.95	247	0	205.2	81%	96%
4/25/07 8:00	15.83	2.97	12.92	7.7	7.9	6.2	1,221	4,345	58	254.18	246	0	205.4	82%	96%
4/25/07 9:00	15.82	2.96	12.92	7.7	7.9	6.2	1,222	4,352	58	253.41	245	0	205.7	82%	96%
4/25/07 10:00	15.76	2.96	12.92	7.7	7.9	6.2	1,223	4,357	58	252.78	245	0	205.9	82%	96%
4/25/07 11:00	15.74	2.96	12.91	7.7	7.9	6.2	1,226	4,350	58	253.32	245	1	205.8	82%	96%
4/25/07 12:00	15.85	2.96	12.95	7.7	7.9	6.2	1,225	4,345	57	252.85	245	0	205.8	82%	96%
4/25/07 13:00	15.85	2.96	12.94	7.7	7.9	6.2	1,227	4,337	58	252.56	244	0	205.9	82%	96%
4/25/07 14:00	15.81	2.96	12.93	7.7	7.9	6.2	1,227	4,335	57	252.25	244	0	206.1	82%	96%
4/25/07 15:00	15.87	2.96	12.91	7.7	7.9	6.2	1,226	4,324	57	252.31	244	0	206.1	81%	96%
4/25/07 16:00	15.78	2.97	12.89	7.7	7.9	6.2	1,226	4,309	57	252.89	245	0	205.9	82%	96%
4/25/07 17:00	15.85	2.97	12.89	7.7	7.9	6.2	1,225	4,292	57	252.85	245	0	205.9	81%	96%
4/25/07 18:00	15.74	2.97	12.88	7.7	7.9	6.2	1,223	4,284	57	253.40	245	0	205.7	82%	96%
4/25/07 19:00	15.78	2.97	12.86	7.7	7.9	6.2	1,221	4,254	56	254.24	246	0	205.5	81%	96%
4/25/07 20:00	15.78	2.98	12.85	7.7	8.0	6.2	1,220	4,240	56	254.70	247	0	205.4	81%	96%
4/25/07 21:00	15.76	2.98	12.85	7.7	8.0	6.2	1,220	4,230	56	254.88	247	0	205.3	82%	96%
4/25/07 22:00	15.76	2.97	12.84	7.7	7.9	6.2	1,220	4,222	56	255.06	247	0	205.2	81%	96%
4/25/07 23:00	15.73	2.98	12.82	7.7	7.9	6.2	1,221	4,215	56	255.22	247	0	205.2	82%	96%
4/26/07 0:00	15.82	2.98	12.81	7.7	7.9	6.2	1,221	4,201	56	255.35	247	0	205.2	81%	96%
4/26/07 1:00	15.72	2.98	12.80	7.7	7.9	6.2	1,221	4,193	55	255.52	247	0	205.2	81%	96%
4/26/07 2:00	15.72	2.98	12.80	7.7	7.9	6.2	1,221	4,183	55	255.71	248	0	205.1	81%	96%
4/26/07 3:00	15.79	2.98	12.78	7.7	7.9	6.2	1,221	4,172	55	255.89	248	0	205.1	81%	96%
4/26/07 4:00	15.71	2.98	12.78	7.7	7.9	6.2	1,221	4,164	55	256.04	248	0	205.1	81%	96%
4/26/07 5:00	15.74	2.98	12.78	7.7	7.9	6.2	1,221	4,157	55	256.14	248	0	205.1	81%	96%
4/26/07 6:00	15.71	2.98	12.77	7.7	7.9	6.2	1,222	4,152	55	256.17	248	0	205.1	81%	96%
4/26/07 7:00	15.79	2.98	12.78	7.7	7.9	6.2	1,221	4,149	55	255.71	248	0	205.2	81%	96%
4/26/07 8:00	15.67	2.97	12.78	7.7	7.9	6.2	1,222	4,152	55	254.79	247	0	205.4	82%	96%
4/26/07 9:00	15.70	2.97	12.78	7.7	7.9	6.2	1,223	4,161	55	253.99	246	0	205.7	81%	96%
4/26/07 10:00	15.70	2.97	12.78	7.7	7.9	6.2	1,224	4,167	55	253.30	245	0	205.9	81%	96%
4/26/07 11:00	15.67	2.96	12.79	7.7	7.9	6.2	1,225	4,150	55	252.77	245	0	206.1	82%	96%
4/26/07 13:00	15.87	3.13	12.81	7.7	7.9	6.2	1,228	5,050	55	250.05	241	0	206.5	81%	96%
4/26/07 14:00	15.87	3.13	12.80	7.7	7.9	6.2	1,229	5,055	55	250.18	242	0	206.4	81%	96%
4/26/07 15:00	15.89	3.13	12.80	7.7	7.9	6.2	1,228	5,045	55	250.46	242	0	206.3	81%	96%
4/26/07 16:00	15.90	3.13	12.80	7.7	7.9	6.2	1,228	5,040	55	250.67	242	0	206.2	81%	96%
4/26/07 17:00	15.84	3.14	12.77	7.7	7.9	6.2	1,226	5,019	54	251.20	243	0	206.1	81%	96%
4/26/07 18:00	15.91	3.14	12.75	7.7	7.9	6.2	1,224	5,015	54	251.85	243	0	205.9	80%	96%
4/26/07 19:00	15.86	3.15	12.73	7.7	7.9	6.2	1,222	4,999	54	252.64	244	0	205.6	80%	96%
4/26/07 20:00	15.84	3.15	12.71	7.7	7.9	6.2	1,221	4,988	53	252.98	244	0	205.5	80%	96%
4/26/07 21:00	15.86	3.15	12.71	7.7	7.9	6.2	1,221	4,976	53	253.26	245	0	205.5	80%	96%
4/26/07 22:00	15.78	3.15	12.71	7.7	7.9	6.2	1,221	4,950	53	253.50	245	0	205.4	81%	96%
4/26/07 23:00	15.83	3.15	12.69	7.7	7.9	6.2	1,221	4,967	53	253.73	245	0	205.3	80%	97%
4/27/07 0:00	15.80	3.15	12.68	7.7	7.9	6.2	1,221	4,944	53	253.90	245	0	205.2	80%	97%
4/27/07 1:00	15.76	3.15	12.68	7.7	7.9	6.2	1,221	4,949	53	254.02	245	0	205.2	80%	97%
4/27/07 2:00	15.79	3.15	12.66	7.7	7.9	6.2	1,221	4,947	53	254.11	246	0	205.2	80%	97%
4/27/07 3:00	15.81	3.15	12.65	7.7	7.9	6.2	1,221	4,946	53	254.22	246	0	205.2	80%	97%
4/27/07 4:00	15.84	3.15	12.65	7.7	7.9	6.2	1,222	4,949	53	254.29	246	0	205.2	80%	97%
4/27/07 5:00	15.72	3.15	12.65	7.7	7.9	6.2	1,222	4,944	53	254.32	246	0	205.2	80%	97%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
4/27/07 6:00	15.76	3.15	12.64	7.7	7.9	6.2	1,222	4,950	52	254.45	246	0	205.1	80%	97%
4/27/07 7:00	15.76	3.15	12.65	7.7	7.9	6.2	1,221	4,952	52	253.94	245	0	205.3	80%	97%
4/27/07 8:00	15.76	3.15	12.67	7.7	7.9	6.2	1,221	4,959	52	253.01	245	0	205.6	80%	97%
4/27/07 9:00	15.76	3.14	12.67	7.7	7.9	6.2	1,223	4,961	53	252.03	244	0	205.9	80%	97%
4/27/07 10:00	15.75	3.13	12.67	7.7	7.9	6.2	1,225	4,992	53	251.08	243	0	206.2	80%	97%
4/27/07 11:00	15.81	3.13	12.68	7.7	7.9	6.2	1,227	5,018	53	250.20	242	0	206.5	80%	97%
4/27/07 12:00	15.69	3.12	12.67	7.6	7.9	6.2	1,229	5,033	53	249.50	241	0	206.7	81%	97%
4/27/07 13:00	15.67	3.11	12.66	7.6	7.9	6.2	1,231	5,045	53	249.14	241	0	206.8	81%	97%
4/27/07 14:00	15.76	3.11	12.66	7.6	7.9	6.2	1,232	5,054	53	249.15	241	0	206.9	80%	97%
4/27/07 15:00	15.74	3.12	12.64	7.6	7.9	6.2	1,230	5,037	53	249.96	241	0	206.5	80%	97%
4/27/07 16:00	15.73	3.12	12.64	7.7	7.9	6.2	1,227	5,010	53	250.64	242	0	206.3	80%	97%
4/27/07 17:00	15.68	3.13	12.62	7.7	7.9	6.2	1,227	5,006	52	251.00	242	0	206.2	80%	97%
4/27/07 18:00	15.68	3.13	12.60	7.7	7.9	6.2	1,226	4,989	52	251.54	243	0	206.1	80%	97%
4/27/07 19:00	15.69	3.13	12.57	7.7	7.9	6.2	1,224	4,963	52	252.26	244	0	205.9	80%	97%
4/27/07 20:00	15.76	3.14	12.56	7.7	7.9	6.2	1,223	4,955	52	252.80	244	0	205.7	80%	97%
4/27/07 21:00	15.66	3.14	12.55	7.7	7.9	6.2	1,222	4,950	52	253.24	245	0	205.5	80%	97%
4/27/07 22:00	15.66	3.15	12.54	7.7	7.9	6.2	1,221	4,939	51	253.61	245	0	205.4	80%	97%
4/27/07 23:00	15.69	3.15	12.54	7.7	7.9	6.2	1,221	4,933	51	253.87	245	0	205.4	80%	97%
4/28/07 0:00	15.65	3.15	12.52	7.7	7.9	6.2	1,221	4,930	51	254.08	246	0	205.3	80%	97%
4/28/07 1:00	15.65	3.15	12.52	7.7	7.9	6.2	1,222	4,922	51	254.16	246	0	205.3	80%	97%
4/28/07 2:00	15.60	3.14	12.52	7.7	7.9	6.2	1,223	4,927	51	254.22	246	0	205.3	80%	97%
4/28/07 3:00	15.68	3.15	12.51	7.7	7.9	6.2	1,221	4,874	51	254.46	246	0	205.2	80%	97%
4/28/07 4:00	15.62	3.15	12.51	7.7	7.9	6.2	1,221	4,881	51	254.61	246	0	205.1	80%	97%
4/28/07 5:00	15.66	3.15	12.49	7.7	7.9	6.2	1,221	4,897	51	254.71	246	0	205.1	80%	97%
4/28/07 6:00	15.64	3.15	12.49	7.7	7.9	6.2	1,221	4,900	51	254.78	246	0	205.2	80%	97%
4/28/07 7:00	15.60	3.15	12.51	7.7	7.9	6.2	1,221	4,913	51	254.32	246	0	205.2	80%	97%
4/28/07 8:00	15.65	3.15	12.50	7.7	7.9	6.2	1,221	4,911	51	253.46	245	0	205.6	80%	97%
4/28/07 9:00	15.64	3.14	12.50	7.7	7.9	6.2	1,223	4,927	51	252.52	244	0	205.9	80%	97%
4/28/07 10:00	15.60	3.13	12.49	7.7	7.9	6.2	1,226	4,953	51	251.56	243	0	206.1	80%	97%
4/28/07 11:00	15.55	3.13	12.48	7.7	7.9	6.2	1,228	4,963	51	250.79	242	0	206.4	80%	97%
4/28/07 12:00	15.52	3.12	12.47	7.7	7.9	6.2	1,230	4,987	51	250.76	242	0	206.4	80%	97%
4/28/07 13:00	15.57	3.13	12.47	7.7	7.9	6.2	1,231	4,988	51	250.81	242	0	206.4	80%	97%
4/28/07 14:00	15.57	3.13	12.45	7.7	7.9	6.2	1,232	4,987	51	250.95	243	0	206.3	80%	97%
4/28/07 15:00	15.51	3.12	12.44	7.7	7.9	6.2	1,230	4,974	51	251.15	243	0	206.2	80%	97%
4/28/07 16:00	15.56	3.13	12.42	7.7	7.9	6.2	1,229	4,955	51	251.43	243	0	206.1	80%	97%
4/28/07 17:00	15.56	3.13	12.40	7.7	7.9	6.2	1,227	4,936	51	252.14	244	0	206.0	80%	97%
4/28/07 18:00	15.49	3.14	12.37	7.7	7.9	6.2	1,224	4,910	50	253.17	245	0	205.6	80%	97%
4/28/07 19:00	15.44	3.15	12.35	7.7	7.9	6.2	1,223	4,884	50	254.12	246	0	205.4	80%	97%
4/28/07 20:00	15.47	3.15	12.34	7.7	7.9	6.2	1,222	4,877	50	254.59	246	0	205.2	80%	97%
4/28/07 21:00	15.49	3.16	12.34	7.7	7.9	6.2	1,222	4,870	50	254.94	247	0	205.1	80%	97%
4/28/07 22:00	15.42	3.15	12.33	7.7	7.9	6.2	1,220	4,863	50	255.10	247	0	205.1	80%	97%
4/28/07 23:00	15.47	3.16	12.33	7.7	7.9	6.2	1,221	4,863	50	255.28	247	0	205.1	80%	97%
4/29/07 0:00	15.45	3.16	12.32	7.7	7.9	6.2	1,221	4,857	50	255.37	247	0	205.1	80%	97%
4/29/07 1:00	15.49	3.16	12.32	7.7	7.9	6.2	1,221	4,855	50	255.49	247	0	205.0	80%	97%
4/29/07 2:00	15.47	3.16	12.32	7.7	7.9	6.2	1,223	4,857	50	255.38	247	0	205.1	80%	97%
4/29/07 3:00	15.45	3.16	12.31	7.7	7.9	6.2	1,224	4,864	50	255.47	247	0	205.1	80%	97%
4/29/07 4:00	15.48	3.16	12.31	7.7	7.9	6.2	1,224	4,852	50	255.51	247	0	205.0	80%	97%
4/29/07 5:00	15.44	3.16	12.31	7.7	7.9	6.2	1,225	4,862	50	255.47	247	0	205.1	80%	97%
4/29/07 6:00	15.46	3.16	12.29	7.7	7.9	6.2	1,225	4,861	50	255.52	247	0	205.1	80%	97%
4/29/07 7:00	15.44	3.16	12.30	7.7	7.9	6.2	1,224	4,860	50	255.42	247	0	205.1	80%	97%
4/29/07 8:00	15.49	3.16	12.29	7.7	7.9	6.2	1,222	4,847	50	255.12	247	0	205.2	79%	97%
4/29/07 9:00	15.42	3.16	12.28	7.7	7.9	6.2	1,222	4,853	50	254.88	247	0	205.3	80%	97%
4/29/07 10:00	15.36	3.15	12.29	7.7	7.9	6.2	1,222	4,856	50	254.13	246	0	205.4	80%	97%
4/29/07 11:00	15.35	3.15	12.28	7.7	7.9	6.1	1,224	4,868	50	253.16	245	0	205.7	80%	97%
4/29/07 12:00	15.39	3.14	12.27	7.7	7.9	6.1	1,225	4,884	50	252.54	244	0	206.0	80%	97%
4/29/07 13:00	15.42	3.14	12.28	7.7	7.9	6.1	1,227	4,897	50	252.70	244	0	205.9	80%	97%
4/29/07 14:00	15.41	3.14	12.27	7.7	7.9	6.2	1,227	4,888	50	253.00	245	0	205.8	80%	97%
4/29/07 15:00	15.42	3.14	12.26	7.7	7.9	6.2	1,226	4,874	50	253.02	245	0	205.8	80%	97%
4/29/07 16:00	15.33	3.14	12.25	7.7	7.9	6.2	1,226	4,873	50	253.26	245	0	205.7	80%	97%
4/29/07 17:00	15.39	3.15	12.22	7.7	7.9	6.2	1,222	4,849	49	254.13	246	0	205.5	79%	97%
4/29/07 18:00	15.31	3.16	12.19	7.7	7.9	6.2	1,220	4,819	49	255.13	247	0	205.2	80%	97%
4/29/07 19:00	15.38	3.16	12.18	7.7	7.9	6.2	1,220	4,808	49	255.89	248	0	205.0	79%	97%
4/29/07 20:00	15.29	3.16	12.17	7.7	7.9	6.2	1,220	4,805	49	256.03	248	0	205.0	80%	97%
4/29/07 21:00	15.35	3.16	12.17	7.7	7.9	6.2	1,221	4,804	49	256.02	248	0	205.0	79%	97%
4/29/07 22:00	15.33	3.16	12.16	7.7	7.9	6.2	1,222	4,807	49	256.08	248	0	205.0	79%	97%
4/29/07 23:00	15.34	3.16	12.16	7.7	7.9	6.2	1,222	4,811	49	256.19	248	0	205.0	79%	97%
4/30/07 0:00	15.33	3.16	12.15	7.7	7.9	6.2	1,222	4,809	49	256.17	248	0	205.0	79%	97%
4/30/07 1:00	15.27	3.16	12.15	7.7	7.9	6.2	1,223	4,815	49	256.10	248	0	205.0	80%	97%
4/30/07 2:00	15.22	3.16	12.15	7.7	7.9	6.2	1,224	4,816	49	256.11	248	0	205.0	80%	97%
4/30/07 3:00	15.31	3.16	12.14	7.7	7.9	6.2	1,224	4,816	49	256.14	248	0	205.0	79%	97%
4/30/07 4:00	15.30	3.16	12.13	7.7	7.9	6.2	1,225	4,817	49	256.12	248	0	205.0	79%	97%
4/30/07 5:00	15.32	3.16	12.13	7.7	7.9	6.2	1,224	4,811	49	256.16	248	0	205.0	79%	97%
4/30/07 6:00	15.27	3.16	12.13	7.7	7.9	6.2	1,224	4,810	49	256.21	248	0	205.0	79%	97%
4/30/07 7:00	15.25	3.17	12.13	7.7	7.9	6.2	1,225	4,810	49	256.16	248	0	205.0	80%	97%
4/30/07 8:00	15.30	3.16	12.12	7.7	7.9	6.2	1,222	4,800	49	255.89	248	0	205.1	79%	97%
4/30/07 9:00	15.28	3.16	12.15	7.7	7.9	6.2	1,220	4,803	49	255.18	247	0	205.3	79%	97%
4/30/07 10:00	15.27	3.16	12.14	7.7	7.9	6.1	1,222	4,819	49	254.32	246	0	205.6	80%	97%
4/30/07 11:00	15.25	3.15	12.15	7.7	7.9	6.1	1,224	4,840	49	253.41	245	0	205.9	80%	97%
4/30/07 12:00	15.25	3.14	12.13	7.7	7.9	6.1	1,226	4,854	49	252.63	244	0	206.2	80%	97%
4/30/07 13:00	15.25	3.14	12.12	7.7	7.9	6.1	1,227	4,861	49	252.19	244	0	206.3	79%	97%
4/30/07 14:00	15.23	3.14	12.11	7.7	7.9	6.1	1,229	4,859	49	252.69	244	0	206.1	80%	97%
4/30/07 15:00	15.19	3.15	12.10	7.7	7.9	6.1	1,228	4,854	49	252.75	245	0	206.1	80%	97%
4/30/07 16:00	15.21	3.15	12.06	7.7	7.9	6.2	1,225	4,828	49	253.64	245	0	205.8	79%	97%
4/30/07 17:00	15.23	3.15	12.04	7.7	7.9	6.2	1,223	4,605	49	254.17	246	0	205.6	79%	97%
4/30/07 18:00	15.14	3.16	12.03	7.7	7.9	6.2	1,222	4,694	49	254.60	246	0	205.5	80%	97%
4/30/07 19:00	15.18	3.16	12.01	7.7	7.9	6.2	1,221	4,692	49	255.07	247	0	205.4	79%	97%
4/30/07 20:00	15.16	3.16	12.00	7.7	7.9	6.2	1,220	4,658	48	255.59	247	0	205.2	79%	97%
4/30/07 21:00	15.13	3.17	11.99	7.7	7.9	6.2	1,220	4,665	48	255.96	248	0	205.1	79%	97%
4/30/07 22:00	15.17	3.16	11.99	7.7	7.9	6.2	1,220	4,664	48	256.24	248	0	205.0	79%	97%
4/30/07 23:00	15.17	3.17	11.98	7.7	7.9	6.2	1,220	4,657	48	256.48	248	0	205.0	79%	97%
5/1/07 0:00	15.12	3.17	11.98	7.7	7.9	6.2	1,220	4,657	48	256.58	248	0	204.9	79%	97%
5/1/07 1:00	15.17	3.17	11.97	7.7	7.9	6.2	1,222	4,659	48	256.64	249	0	204.9	79%	97%
5/1/07 2:00	15.15	3.17	11.96	7.7	7.9	6.2	1,220	4,655	48	256.83	249	0	204.9	79%	97%
5/1/07 3:00	15.09	3.17	11.95	7.7	7.9	6.2	1,219	4,646	48	257.08	249	0	204.8	79%	97%
5/1/07 4:00	15.16	3.17	11.94	7.7	7.9	6.2	1,219	4,628	48	257.16	249	0	204.9	79%	97%
5/1/07 5:00	15.09	3.17	11.93	7.7	7.9	6.2	1,220	4,609	48	257.30	249	0	204.7	79%	97%
5/1/07 6:00	15.09	3.17	11.94	7.7	7.9	6.2	1,220	4,626	48	257.31	249	0	204.7	79%	97%

Date/Time	Flow(FEED)	Flow(CONC)	Flow(PERM)	pH(FEED)	pH(CONC)	pH(PERM)	TDS(FEED)	TDS(CONC)	TDS(PERM)	Press(FEED)	Press(CONC)	Press(Perm)	DeltaFilterPress	Water Recovery	TDS Rejection
5/1/07 7:00	15.10	3.16	11.94	7.7	7.9	6.2	1,221	4,632	49	256.25	248	0	204.8	79%	97%
5/1/07 8:00	15.14	3.16	11.95	7.7	7.9	6.1	1,221	4,649	49	255.29	247	0	205.2	79%	97%
5/1/07 9:00	15.13	3.16	11.95	7.7	7.9	6.1	1,223	4,674	49	254.51	246	0	205.5	79%	97%
5/1/07 10:00	15.10	3.15	11.95	7.7	7.9	6.1	1,225	4,690	49	253.96	246	0	205.7	79%	97%
5/1/07 11:00	15.06	3.15	11.95	7.7	7.9	6.1	1,225	4,700	49	253.29	245	0	205.9	79%	97%
5/1/07 12:00	15.04	3.15	11.96	7.7	7.9	6.1	1,226	4,710	49	253.02	245	0	206.0	80%	97%
5/1/07 13:00	15.08	3.15	11.95	7.7	7.9	6.1	1,227	4,722	49	253.05	245	0	206.0	79%	97%
5/1/07 14:00	15.10	3.15	11.94	7.7	7.9	6.1	1,228	4,726	49	253.05	245	0	206.0	79%	97%
5/1/07 15:00	15.03	3.15	11.91	7.7	7.9	6.1	1,227	4,718	49	253.45	245	0	205.8	79%	97%
5/1/07 16:00	15.00	3.15	11.89	7.7	7.9	6.2	1,224	4,696	48	254.22	246	0	205.6	79%	97%
5/1/07 17:00	14.99	3.16	11.87	7.7	7.9	6.2	1,222	4,673	48	255.10	247	0	205.3	79%	97%
5/1/07 18:00	15.03	3.16	11.86	7.7	7.9	6.2	1,221	4,666	48	255.38	247	0	205.3	79%	97%
5/1/07 19:00	15.02	3.17	11.86	7.7	7.9	6.2	1,220	4,656	48	255.80	248	0	205.1	79%	97%
5/1/07 20:00	14.98	3.17	11.84	7.7	7.9	6.2	1,220	4,649	48	256.08	248	0	205.0	79%	97%
5/1/07 21:00	15.05	3.17	11.85	7.7	7.9	6.2	1,220	4,649	48	256.13	248	0	205.0	79%	97%
5/1/07 22:00	14.99	3.17	11.85	7.7	7.9	6.2	1,221	4,651	48	256.12	248	0	205.0	79%	97%
5/1/07 23:00	15.04	3.17	11.84	7.7	7.9	6.2	1,223	4,652	48	256.15	248	0	205.0	79%	97%
5/2/07 0:00	14.97	3.17	11.83	7.7	7.9	6.2	1,221	4,620	48	256.38	248	0	204.9	79%	97%
5/2/07 1:00	14.98	3.17	11.82	7.7	7.9	6.2	1,220	4,606	48	256.60	249	0	204.9	79%	97%
5/2/07 2:00	14.95	3.16	11.82	7.7	7.9	6.2	1,220	4,605	48	256.59	249	0	204.9	79%	97%
5/2/07 3:00	14.99	3.17	11.82	7.7	7.9	6.2	1,222	4,615	48	256.59	249	0	204.9	79%	97%
5/2/07 4:00	14.99	3.17	11.81	7.7	7.9	6.2	1,223	4,618	48	256.51	248	0	204.9	79%	97%
5/2/07 5:00	14.99	3.17	11.80	7.7	7.9	6.2	1,223	4,621	48	256.42	248	0	205.0	79%	97%
5/2/07 6:00	15.03	3.17	11.80	7.7	7.9	6.2	1,222	4,615	48	256.30	248	0	205.0	79%	97%
5/2/07 7:00	14.93	3.17	11.80	7.7	7.9	6.2	1,221	4,609	48	256.02	248	0	205.0	79%	97%
5/2/07 8:00	14.99	3.16	11.80	7.7	7.9	6.2	1,220	4,612	48	255.67	248	0	205.2	79%	97%
5/2/07 9:00	14.94	3.16	11.81	7.7	7.9	6.1	1,221	4,616	48	255.26	247	0	205.3	79%	97%
5/2/07 10:00	14.92	3.17	11.79	7.7	7.9	6.1	1,222	4,618	48	255.29	247	0	205.3	79%	97%
5/2/07 11:00	14.92	3.16	11.79	7.7	7.9	6.2	1,223	4,617	48	255.33	247	0	205.2	79%	97%
5/2/07 12:00	15.00	3.16	11.78	7.7	7.9	6.1	1,222	4,622	48	254.80	247	0	205.5	79%	97%
5/2/07 13:00	14.89	3.16	11.79	7.7	7.9	6.1	1,223	4,635	48	254.55	247	0	205.5	79%	97%
5/2/07 14:00	14.93	3.16	11.79	7.7	7.9	6.1	1,223	4,645	48	254.18	246	0	205.6	79%	97%
5/2/07 15:00	14.92	3.16	11.79	7.7	7.9	6.1	1,225	4,650	48	254.16	246	0	205.6	79%	97%
5/2/07 16:00	14.90	3.16	11.77	7.7	7.9	6.2	1,226	4,645	48	254.30	246	0	205.5	79%	97%
5/2/07 17:00	14.92	3.16	11.75	7.7	7.9	6.2	1,224	4,636	48	254.63	247	0	205.5	79%	97%
5/2/07 18:00	14.91	3.16	11.73	7.7	7.9	6.2	1,222	4,621	48	255.16	247	0	205.3	79%	97%
5/2/07 19:00	14.89	3.17	11.70	7.7	7.9	6.2	1,221	4,609	48	255.83	248	0	205.1	79%	97%
5/2/07 20:00	14.78	3.17	11.70	7.7	7.9	6.2	1,219	4,600	48	256.35	248	0	204.9	79%	97%
5/2/07 21:00	14.84	3.17	11.69	7.7	7.9	6.2	1,219	4,592	48	256.71	249	0	204.8	79%	97%
5/2/07 22:00	14.86	3.17	11.68	7.7	7.9	6.2	1,219	4,587	48	256.97	249	0	204.7	79%	97%
5/2/07 23:00	14.88	3.17	11.68	7.7	7.9	6.2	1,219	4,582	48	257.19	249	0	204.6	79%	97%
5/3/07 0:00	14.88	3.17	11.67	7.7	7.9	6.2	1,219	4,584	48	257.23	249	0	204.6	78%	97%
5/3/07 1:00	14.91	3.17	11.68	7.7	7.9	6.2	1,220	4,585	48	257.31	249	0	204.6	78%	97%
5/3/07 2:00	14.84	3.17	11.67	7.7	7.9	6.2	1,220	4,578	48	257.42	249	0	204.6	79%	97%
5/3/07 3:00	14.82	3.18	11.66	7.7	7.9	6.2	1,220	4,576	48	257.59	250	0	204.5	79%	97%
5/3/07 4:00	14.83	3.17	11.65	7.7	7.9	6.2	1,220	4,574	48	257.57	250	0	204.6	79%	97%
5/3/07 5:00	14.86	3.18	11.65	7.7	7.9	6.2	1,221	4,579	48	257.47	250	0	204.5	78%	97%
5/3/07 6:00	14.77	3.18	11.65	7.7	7.9	6.2	1,222	4,582	48	257.39	249	0	204.6	79%	97%
5/3/07 7:00	14.82	3.17	11.65	7.7	7.9	6.2	1,221	4,577	48	256.92	249	0	204.6	79%	97%
5/3/07 8:00	14.83	3.17	11.65	7.7	7.9	6.2	1,220	4,578	48	256.02	248	0	204.8	79%	97%
5/3/07 9:00	14.85	3.16	11.65	7.7	7.9	6.1	1,221	4,589	48	255.57	248	0	205.0	78%	97%
5/3/07 10:00	14.85	3.16	11.67	7.7	7.9	6.1	1,221	4,599	48	255.06	247	0	205.2	79%	97%
5/3/07 11:00	14.86	3.17	11.67	7.7	7.9	6.1	1,222	4,608	48	254.71	247	0	205.4	79%	97%
5/3/07 12:00	14.83	3.16	11.68	7.7	7.9	6.1	1,223	4,620	48	254.26	246	0	205.5	79%	97%
5/3/07 13:00	14.86	3.16	11.66	7.7	7.9	6.1	1,224	4,622	48	254.55	247	0	205.4	78%	97%
5/3/07 14:00	14.82	3.16	11.66	7.7	7.9	6.2	1,224	4,614	48	254.87	247	0	205.3	79%	97%
5/3/07 15:00	14.88	3.16	11.65	7.7	7.9	6.2	1,224	4,614	48	254.85	247	0	205.3	78%	97%
5/3/07 16:00	14.79	3.17	11.64	7.7	7.9	6.2	1,223	4,608	48	255.15	247	0	205.3	79%	97%
5/3/07 17:00	14.81	3.16	11.62	7.7	7.9	6.2	1,221	4,592	48	255.53	248	0	205.1	78%	97%
5/3/07 18:00	14.80	3.17	11.61	7.7	7.9	6.2	1,220	4,586	48	255.80	248	0	205.0	79%	97%
5/3/07 19:00	14.80	3.17	11.60	7.7	7.9	6.2	1,220	4,573	48	256.12	248	0	204.9	78%	97%
5/3/07 20:00	14.85	3.17	11.60	7.7	7.9	6.2	1,219	4,570	48	256.28	248	0	204.9	78%	97%
5/3/07 21:00	14.76	3.17	11.59	7.7	7.9	6.2	1,220	4,570	48	256.32	248	0	204.9	79%	97%
5/3/07 22:00	14.71	3.17	11.59	7.7	7.9	6.2	1,220	4,567	48	256.36	248	0	204.9	79%	97%
5/3/07 23:00	14.77	3.17	11.59	7.7	7.9	6.2	1,222	4,568	48	256.32	248	0	204.9	78%	97%
5/4/07 0:00	14.80	3.17	11.59	7.7	7.9	6.2	1,223	4,569	48	256.33	248	0	204.9	78%	97%
5/4/07 1:00	14.76	3.17	11.57	7.7	7.9	6.2	1,222	4,563	48	256.44	249	0	204.9	78%	97%
5/4/07 2:00	14.73	3.17	11.58	7.7	7.9	6.2	1,221	4,559	48	256.44	249	0	204.9	79%	97%
5/4/07 3:00	14.78	3.17	11.57	7.7	7.9	6.2	1,221	4,559	48	256.49	249	0	204.9	78%	97%
5/4/07 4:00	14.69	3.17	11.56	7.7	7.9	6.2	1,222	4,560	48	256.48	249	0	204.9	79%	97%
5/4/07 5:00	14.71	3.17	11.56	7.7	7.9	6.2	1,222	4,557	48	256.54	249	0	204.9	79%	97%
5/4/07 6:00	14.75	3.17	11.56	7.7	7.9	6.2	1,222	4,556	48	256.51	249	0	204.9	78%	97%
5/4/07 7:00	14.69	3.17	11.54	7.7	7.9	6.2	1,223	4,559	48	256.13	248	0	204.9	79%	97%
5/4/07 8:00	14.73	3.16	11.55	7.7	7.9	6.2	1,222	4,557	48	255.71	248	0	205.0	78%	97%
5/4/07 9:00	14.71	3.17	11.55	7.7	7.9	6.1	1,221	4,556	48	255.39	247	0	205.1	79%	97%
5/4/07 10:00	14.77	3.16	11.56	7.7	7.9	6.1	1,222	4,567	48	255.22	247	0	205.2	78%	97%
5/4/07 11:00	14.76	3.16	11.56	7.7	7.9	6.1	1,223	4,578	48	254.59	247	0	205.4	78%	97%
5/4/07 12:00	14.71	3.16	11.55	7.7	7.9	6.1	1,226	4,583	48	254.96	247	0	205.4	78.51%	97%



Appendix E

Detailed Technology Comparison Life Cycle Cost Estimates

Pajaro River Watershed Groundwater Desalination Feasibility Study

RMC
Water and Environment

Project: Pajaro River Watershed GW Desal Feas. Study
Aspect: Cost Estimate Comparison

Estimate Type: Feasibility Study

Date: September 21, 2006
Project Number: 076-009
Prepared by: MPV
Checked by: DGG
Check Date: 8/30/2006

Elements/Systems	BW30-400	XLE-440	NF90-400
Groundwater Extraction/Conveyance	$ 5,825,000	$ 5,825,000	$ 5,825,000
Desalination Facility	$ 8,412,000	$ 8,578,000	$ 8,842,000
Blended Water Transmission	$ 779,000	$ 779,000	$ 779,000
Brine Concentration	$ -	$ -	$ -
RAW CONST. COST	**$ 15,020,000**	**$ 15,180,000**	**$ 15,450,000**
Project Contingency	$ 4,510,000	$ 4,550,000	$ 4,640,000
Change Order Contingency	$ 980,000	$ 990,000	$ 1,000,000
Engineering/Environmental Allowance	$ 3,910,000	$ 3,950,000	$ 4,020,000
Legal/Administrative Allowance	$ 1,950,000	$ 1,970,000	$ 2,010,000
Construction Management Allowance	$ 1,950,000	$ 1,970,000	$ 2,010,000
TOTAL CAPITAL COST	**$ 28,320,000**	**$ 28,610,000**	**$ 29,130,000**
Consumables	$ 340,000	$ 386,000	$ 406,000
Power	$ 488,000	$ 392,000	$ 379,000
Labor	$ 94,000	$ 94,000	$ 94,000
Chemicals	$ 53,000	$ 54,000	$ 54,000
TOTAL ANNUAL O&M COST	**$ 975,000**	**$ 925,000**	**$ 933,000**
PRESENT WORTH O&M COST	**$ 14,990,000**	**$ 14,220,000**	**$ 14,340,000**
TOTAL PRESENT WORTH COST	**$ 43,310,000**	**$ 42,830,000**	**$ 43,470,000**

RMC
Water and Environment

Project:	**Pajaro IRWMP Groundwater Export**	Date:	September 21, 2006
		Project Number:	076-009
Aspect:	**General Unit Cost Criteria**	Prepared by:	MPV
		Checked by:	DGG
Estimate Type:	Feasibility Study	Check Date:	8/30/2006

Cost Criteria

Project Contingency	30%	of raw construction cost
Change Order Contingency	5%	of total construction cost including contingency
Engineering/Environmental Allowance	20%	of total construction cost including contingency
Admin/Legal Allowance	10%	of total construction cost including contingency
Construction Management Allowance	10%	of total construction cost including contingency
Project Life Cycle	30	years
Interest Rate	5%	
Present Worth Factor	15.37	
Annualization Factor	0.0651	
Unit Cost Reference Date	June 2006	8440.73
Cost Estimate Reference Date	May 2007	9116.72
Unit Cost Adjustment Factor		1.07

Unit Costs

Item	Unit Cost	Units	
Pipe (installed open cut)	$ 7.50	$/in dia/LF	
Pipe (installed bore and jack)	$ 20.00	$/in dia/LF	
Pipeline Appurtenances	10%		
Land Acquisition	$ 35,000	$/ACRE	
Right of Way	$ 8,000	$/ACRE	
Concrete Storage Tank	$ 1.60	$/gal	
Intermediate Well Development Cost	$ 900.00	$/FT	incl. pumps etc...
Deep Well Development Cost	$ 650.00	$/FT	
Building Cost	$ 150.00	$/SF	
Chemical Feed Pumps	$ 12,000.00	$/EA	(all accessories incl.)
5000 gal storage tank	$ 12,000.00	$/EA	
3000 gal storage tank	$ 9,000.00	$/EA	
BW Membrane System	$ 400,000	$/mgd	
XLE Membrane System	$ 425,000	$/mgd	
NF Membrane System	$ 475,000	$/mgd	
Decarbonation	$ 125,000	$/mgd	
Concrete	$ 750	$/CY	
Chemical Facility Roofing	$ 40	$/SF	
Pump Station	$ 2,500.00	$/HP	
BW RO Membrane Replacment	$ 800.00	$/EA	
XLE RO Membrane Replacement	$ 1,100.00	$/EA	
NF Membrane Replacement	$ 1,200.00	$/EA	
Energy Costs	$ 0.15	$/kWh	
Operator Labor	$ 60.00	$/HR	

Conversion Factors

Pump Efficiency	70%	
cf	7.48	gal
g water	62.43	lb/ft3
ft*lb	3.8E-07	kWh
AF	0.32585	MGD

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Project:	**Pajaro River Watershed GW Desal Feas. Study**	Date:	September 21, 2006
		Project Number:	076-009
Aspect:	**Reverse Osmosis - BW30-400 System**	Prepared by:	MPV
		Checked by:	DGG
Estimate Type:	Feasibility Study	Check Date:	8/30/2006

Spec. Division	Item	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
Groundwater Extraction/Conveyance							$ 5,825,000	
	Intermediate Depth Groundwater Well	150	FT	0	EA	$ 145,010	$ -	
	Deep Groundwater Wells	500	FT	8	EA	$ 349,098	$ 2,792,786	
	Connecting Piping	14	IN	5700	LF	$ 112.79	$ 642,878	2 columns of 10 wells each, 300' spacing
	Transmission Piping	21	IN	10560	LF	$ 169.18	$ 1,786,524	
	Pipeline Appurtenances					10%	$ 242,940	
	Misc Mechanical/Piping			1	LS	$ 107,415	$ 107,415	
	Misc Electrical/Instrumentation			8	Wells	$ 21,483	$ 171,864	includes 1 power drop per well plus radio telemetry
	Corrosion Protection			1	LS	$ 80,561	$ 80,561	
Desalination Facility							$ 8,412,000	
	Land Acquisition			2	AC	$ 37,595	$ 75,190	
	Fencing/Security Allowance			1	LS	$ 53,707	$ 53,707	
	Earthwork Allowance			1	LS	$ 53,707	$ 53,707	
	Roadways/Paving			1	LS	$ 53,707	$ 53,707	
	Site Drainage			1	LS	$ 32,224	$ 32,224	
	Landscaping			1	LS	$ 42,966	$ 42,966	
	Influent Equalization			1,280,000	GAL	$ 1.72	$ 2,199,856	
	Equalization Return Pumps	889	GPM	4	EA	$ 32,224	$ 128,898	3 DUTY, 1 SPARE
	Membrane Building			2,400	SF	$ 161	$ 386,693	Assume 60' x 40'
	Membrane System			2.53	MGD	$ 429,659	$ 1,087,038	
	Chemical Facility Slab			56	CY	$ 806	$ 44,756	18" thick, 50' x 20'
	Chemical Facility Walls/Misc Concrete			1	LS	$ 32,224	$ 32,224	
	Chemical Facility Roof Structure			1,000	SF	$ 43	$ 42,966	
	Chemical Pumps			5	EA	$ 12,890	$ 64,449	
	Anti-Scalant Tanks	5000	gal	2	EA	$ 12,890	$ 25,780	
	Cleaning Solution Tanks	3000	gal	1	EA	$ 9,667	$ 9,667	
	Waste Cleaning Solution Tanks	3000	gal	1	EA	$ 9,667	$ 9,667	
	Decarbonation			2.53	MGD	$ 134,269	$ 339,699	
	Blended Water Storage			1,000,000	GAL	$ 1.72	$ 1,718,637	
	Product Water Pump Station			300	HP	$ 2,685	$ 805,611	Total HP = 1.33*Duty HP...corresponds to 3 duty + 1 standby pump
	Instrumentation Allowance					7.50%	$ 548,615	
	Electrical Supply/Distribution Allowance					7.50%	$ 548,615	
	Piping Allowance			1	LS	$ 107,415	$ 107,415	
Blended Water Transmission							$ 779,000	
	Transmission Piping	14	IN	5280	LF	$ 112.79	$ 595,508	
	Pipeline Appurtenances					10%	$ 59,551	
	Misc Mechanical/Piping			1	LS	$ 53,707	$ 53,707	
	Misc Instrumentation			1	LS	$ 26,854	$ 26,854	
	Corrosion Protection			1	LS	$ 42,966	$ 42,966	
Brine Concentration							$ -	

Equipment Subtotal	$	2,425,696	These subtotals do not represent the entire raw construction cost for the facility. They are used for the calculation of O&M costs for the various elements.
Mechanical/Storage Subtotal	$	7,602,511	
Electrical/Instrumentation Subtotal	$	1,295,947	
FACILITY RAW CONSTRUCTION COST	**$**	**15,020,000**	
Project Contingency	$	4,510,000	30%
Change Order Contingency	$	980,000	5%
Engineering/Environmental Allowance	$	3,910,000	20%
Legal/Administrative Allowance	$	1,950,000	10%
Construction Management Allowance	$	1,950,000	10%
FACILITY TOTAL CAPITAL COST	**$**	**28,320,000**	

ANNUAL O&M COSTS						
Consumables					$ 340,000	
Membrane Replacement	142	EA	$	800	$ 113,867	427 membranes total, 3 year replacement
Equipment Consumables				2%	$ 48,514	% of capital cost, plus project contingency
Mechanical/Storage Consumables				2%	$ 152,050	% of capital cost, plus project contingency
Electrical/Instrumentation Consumables				2%	$ 25,919	% of capital cost, plus project contingency
Power					$ 488,000	
Groundwater Wells	540,190	kwh	$	0.15	$ 81,028	
EQ Return Pumps	84,455	kwh	$	0.15	$ 12,668	
High Pressure Pumps	1,715,913	kwh	$	0.15	$ 257,387	
Decarbonation Blowers	163,308	kwh	$	0.15	$ 24,496	assume 25 HP constant operation
Product Water Pumps	749075	kwh	$	0.15	$ 112,361	
Labor					$ 94,000	
Operator	20	HR/WK	$	60	$ 62,400	
Maintenance	10	HR/WK	$	60	$ 31,200	
Chemicals					$ 53,000	
Antiscalant	58485	LBS	$	0.50	$ 29,242	dose assumed at 5 mg/L
Cleaning Chemicals	6000	GAL	$	4.00	$ 24,000	based on filling each PV 4 times per year
TOTAL ANNUAL O&M COSTS					$ 975,000	

PRESENT WORTH O&M COSTS	**$**	**14,990,000**	
TOTAL FACILITY PRESENT WORTH COSTS	**$**	**43,310,000**	30 years at 5% interest

RMC
Water and Environment

Project: Pajaro River Watershed GW Desal Feas. Study

Aspect: Reverse Osmosis - XLE-440 System

Estimate Type: Feasibility Study

Date: September 21, 2006
Project Number: 076-009

Prepared by: MPV
Checked by: DGG
Check Date: 8/30/2006

Spec. Division	Item	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
Groundwater Extraction/Conveyance							**$ 5,824,967**	
	Intermediate Depth Groundwater Well	150	FT	0	EA	$ 145,010	$ -	
	Deep Groundwater Wells	500	FT	8	EA	$ 349,098	$ 2,792,786	
	Connecting Piping	14	IN	5700	LF	$ 112.79	$ 642,878	2 columns of 10 wells each, 300' spacing
	Transmission Piping	21	IN	10560	LF	$ 169.18	$ 1,786,524	
	Pipeline Appurtenances					10%	$ 242,940	
	Misc Mechanical/Piping			1	LS	$ 107,415	$ 107,415	
	Misc Electrical/Instrumentation			8	Wells	$ 21,483	$ 171,864	
	Corrosion Protection			1	LS	$ 80,561	$ 80,561	
Desalination Facility							**$ 8,577,925**	
	Land Acquisition			2	AC	$ 37,595	$ 75,190	
	Fencing/Security Allowance			1	LS	$ 53,707	$ 53,707	
	Earthwork Allowance			1	LS	$ 53,707	$ 53,707	
	Roadways/Paving			1	LS	$ 53,707	$ 53,707	
	Site Drainage			1	LS	$ 32,224	$ 32,224	
	Landscaping			1	LS	$ 42,966	$ 42,966	
	Influent Equalization			1,290,000	GAL	$ 1.72	$ 2,217,042	
	Equalization Return Pumps	898	GPM	4	EA	$ 32,224	$ 128,898	3 DUTY, 1 SPARE
	Membrane Building			2,400	SF	$ 161	$ 386,693	Assume 60' x 40'
	Membrane System			2.63	MGD	$ 456,513	$ 1,200,629	
	Chemical Facility Slab			56	CY	$ 806	$ 44,756	18" thick, 50' x 20'
	Chemical Facility Walls/Misc Concrete			1	LS	$ 32,224	$ 32,224	
	Chemical Facility Roof Structure			1,000	SF	$ 43	$ 42,966	
	Chemical Pumps			5	EA	$ 12,890	$ 64,449	
	Anti-Scalant Tanks	5000	gal	2	EA	$ 12,890	$ 25,780	
	Cleaning Solution Tanks	3000	gal	1	EA	$ 9,667	$ 9,667	
	Waste Cleaning Solution Tanks	3000	gal	1	EA	$ 9,667	$ 9,667	
	Decarbonation			2.63	MGD	$ 134,269	$ 353,126	
	Blended Water Storage			1,000,000	GAL	$ 1.72	$ 1,718,637	
	Product Water Pump Station			300	HP	$ 2,685	$ 805,611	Total HP = 1.33*Duty HP...corresponds to 3 duty + 1 standby pump
	Instrumentation Allowance					7.50%	$ 559,430	
	Electrical Supply/Distribution Allowance					7.50%	$ 559,430	
	Piping Allowance			1	LS	$ 107,415	$ 107,415	
Blended Water Transmission							**$ 778,586**	
	Transmission Piping	14	IN	5280	LF	$ 112.79	$ 595,508	
	Pipeline Appurtenances					10%	$ 59,551	
	Misc Mechanical/Piping			1	LS	$ 53,707	$ 53,707	
	Misc Instrumentation			1	LS	$ 26,854	$ 26,854	
	Corrosion Protection			1	LS	$ 42,966	$ 42,966	
Brine Concentration							**$ -**	

Equipment Subtotal	$ 2,552,714	These subtotals do not represent the entire raw construction cost for the facility. They are used for the calculation of O&M costs for the various elements.
Mechanical/Storage Subtotal	$ 7,619,697	
Electrical/Instrumentation Subtotal	$ 1,317,577	
FACILITY RAW CONSTRUCTION COST	**$ 15,180,000**	
Project Contingency	$ 4,550,000	30%
Change Order Contingency	$ 990,000	5%
Engineering/Environmental Allowance	$ 3,950,000	20%
Legal/Administrative Allowance	$ 1,970,000	10%
Construction Management Allowance	$ 1,970,000	10%
FACILITY TOTAL CAPITAL COST	**$ 28,610,000**	

ANNUAL O&M COSTS	Quantity	Unit	Unit Cost	Total Cost	Notes
Consumables				**$ 386,000**	
Membrane Replacement	142	EA	$ 1,100	$ 156,567	427 membranes total, 3 year replacement
Equipment Consumables			2%	$ 51,054	% of capital cost, plus project contingency
Mechanical/Storage Consumables			2%	$ 152,394	% of capital cost, plus project contingency
Electrical/Instrumentation Consumables			2%	$ 26,352	% of capital cost, plus project contingency
Power				**$ 392,000**	
Groundwater Wells	551,961	kwh	$ 0.15	$ 82,794	
EQ Return Pumps	85,338	kwh	$ 0.15	$ 12,801	
High Pressure Pumps	1,060,709	kwh	$ 0.15	$ 159,106	
Decarbonation Blowers	163,308	kwh	$ 0.15	$ 24,496	assume 25 HP constant operation
Product Water Pumps	749,075	kwh	$ 0.15	$ 112,361	
Labor				**$ 94,000**	
Operator	20	HR/WK	$ 60	$ 62,400	
Maintenance	10	HR/WK	$ 60	$ 31,200	
Chemicals				**$ 54,000**	
Antiscalant	59094	LBS	$ 0.50	$ 29,547	dose assumed at 5 mg/L
Cleaning Chemicals	6000	GAL	$ 4.00	$ 24,000	based on filling each PV 4 times per year
TOTAL ANNUAL O&M COSTS				**$ 925,000**	

PRESENT WORTH O&M COSTS	**$ 14,220,000**	
TOTAL FACILITY PRESENT WORTH COSTS	**$ 42,830,000**	30 years at 5% interest

RMC
Water and Environment

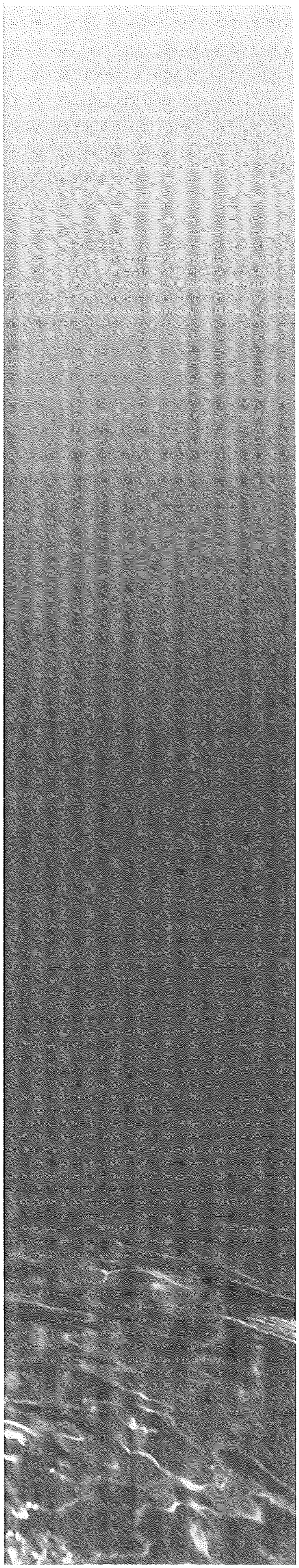
Project:	**Pajaro River Watershed GW Desal Feas. Study**	Date: Project Number:	September 21, 2006 076-009
Aspect:	**Nanofiltration - NF90-400 System**	Prepared by: Checked by:	MPV DGG
Estimate Type:	Feasibility Study	Check Date:	8/30/2006

Spec. Division	Item	Size	Units	Quantity	Unit	Unit Cost	Total Cost	Notes
Groundwater Extraction/Conveyance							$ 5,824,967	
	Intermediate Depth Groundwater Well	150	FT	0	EA	$ 145,010	$ -	
	Deep Groundwater Wells	500	FT	8	EA	$ 349,098	$ 2,792,786	
	Connecting Piping	14	IN	5700	LF	$ 112.79	$ 642,878	2 columns of 10 wells each, 300' spacing
	Transmission Piping	21	IN	10560	LF	$ 169.18	$ 1,786,524	
	Pipeline Appurtenances					10%	$ 242,940	
	Misc Mechanical/Piping			1	LS	$ 107,415	$ 107,415	
	Misc Electrical/Instrumentation			8	Wells	$ 21,483	$ 171,864	
	Corrosion Protection			1	LS	$ 80,561	$ 80,561	
Desalination Facility							$ 8,841,616	
	Land Acquisition			2	AC	$ 35,000	$ 70,000	
	Fencing/Security Allowance			1	LS	$ 53,707	$ 53,707	
	Earthwork Allowance			1	LS	$ 53,707	$ 53,707	
	Roadways/Paving			1	LS	$ 53,707	$ 53,707	
	Site Drainage			1	LS	$ 32,224	$ 32,224	
	Landscaping			1	LS	$ 42,966	$ 42,966	
	Influent Equalization			1,303,000	GAL	$ 1.72	$ 2,239,385	
	Equalization Return Pumps	905	GPM	4	EA	$ 32,224	$ 128,898	3 DUTY, 1 SPARE
	Membrane Building			2,400	SF	$ 161	$ 386,693	Assume 60' x 40'
	Membrane System			2.74	MGD	$ 510,220	$ 1,398,004	
	Chemical Facility Slab			56	CY	$ 806	$ 44,756	18" thick, 50' x 20'
	Chemical Facility Walls/Misc Concrete			1	LS	$ 32,224	$ 32,224	
	Chemical Facility Roof Structure			1,000	SF	$ 43	$ 42,966	
	Chemical Pumps			5	EA	$ 12,890	$ 64,449	
	Anti-Scalant Tanks	5000	gal	2	EA	$ 12,890	$ 25,780	
	Cleaning Solution Tanks	3000	gal	1	EA	$ 9,667	$ 9,667	
	Waste Cleaning Solution Tanks	3000	gal	1	EA	$ 9,667	$ 9,667	
	Decarbonation			2.74	MGD	$ 134,269	$ 367,896	
	Blended Water Storage			1,000,000	GAL	$ 1.72	$ 1,718,637	
	Product Water Pump Station			300	HP	$ 2,685	$ 805,611	Total HP = 1.33*Duty HP...corresponds to 3 duty + 1 standby pump
	Instrumentation Allowance					7.50%	$ 576,627	
	Electrical Supply/Distribution Allowance					7.50%	$ 576,627	
	Piping Allowance			1	LS	$ 107,415	$ 107,415	
Blended Water Transmission							$ 778,586	
	Transmission Piping	14	IN	5280	LF	$ 112.79	$ 595,508	
	Pipeline Appurtenances					10%	$ 59,551	
	Misc Mechanical/Piping			1	LS	$ 53,707	$ 53,707	
	Misc Instrumentation			1	LS	$ 26,854	$ 26,854	
	Corrosion Protection			1	LS	$ 42,966	$ 42,966	
Brine Concentration							$ -	

Equipment Subtotal	$	2,764,858	These subtotals do not represent the entire raw construction cost for the facility. They are used for the calculation of O&M costs for the various elements.
Mechanical/Storage Subtotal	$	7,642,039	
Electrical/Instrumentation Subtotal	$	1,351,972	
FACILITY RAW CONSTRUCTION COST	**$**	**15,450,000**	
Project Contingency	$	4,640,000	30%
Change Order Contingency	$	1,000,000	5%
Engineering/Environmental Allowance	$	4,020,000	20%
Legal/Administrative Allowance	$	2,010,000	10%
Construction Management Allowance	$	2,010,000	10%
FACILITY TOTAL CAPITAL COST	**$**	**29,130,000**	

ANNUAL O&M COSTS	Quantity	Unit	Unit Cost	Total Cost	Notes
Consumables				$ 406,000	
Membrane Replacement	142	EA	$ 1,200	$ 170,800	427 membranes total, 3 year replacement
Equipment Consumables			2%	$ 55,297	% of capital cost, plus project contingency
Mechanical/Storage Consumables			2%	$ 152,841	% of capital cost, plus project contingency
Electrical/Instrumentation Consumables			2%	$ 27,039	% of capital cost, plus project contingency
Power				$ 379,000	
Groundwater Wells	560,745	kwh	$ 0.15	$ 84,112	
EQ Return Pumps	85,986	kwh	$ 0.15	$ 12,898	
High Pressure Pumps	969,498	kwh	$ 0.15	$ 145,425	
Decarbonation Blowers	163,308	kwh	$ 0.15	$ 24,496	assume 25 HP constant operation
Product Water Pumps	749,075	kwh	$ 0.15	$ 112,361	
Labor				$ 94,000	
Operator	20	HR/WK	$ 60	$ 62,400	
Maintenance	10	HR/WK	$ 60	$ 31,200	
Chemicals				$ 54,000	
Antiscalant	59551	LBS	$ 0.50	$ 29,775	dose assumed at 5 mg/L
Cleaning Chemicals	6000	GAL	$ 4.00	$ 24,000	based on filling each PV 4 times per year
TOTAL ANNUAL O&M COSTS				**$ 933,000**	

PRESENT WORTH O&M COSTS	**$**	**14,340,000**	
TOTAL FACILITY PRESENT WORTH COSTS	**$**	**43,470,000**	30 years at 5% interest



Appendix F

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Subchapter 2. Siting and Design

Article 1. [Reserved by SWRCB]

Article 2. SWRCB - Waste Classification and Management

20200. SWRCB - Applicability and Classification Criteria. (C15: Section 2520)

(a) **Concept**—This article contains a waste classification system which applies to solid wastes that cannot be discharged directly or indirectly to waters of the state and which therefore must be discharged to waste management units (**Units**) for treatment, storage, or disposal in accordance with the requirements of this division. Wastes which can be discharged directly or indirectly *(e.g., by percolation)* to waters of the state under effluent or concentration limits that implement applicable water quality control plans *(e.g., municipal or industrial effluent or process wastewater)* are not subject to the SWRCB-promulgated provisions of this division. This waste classification system shall provide the basis for determining which wastes may be discharged at each class of Unit. Waste classifications are based on an assessment of the potential risk of water quality degradation associated with each category of waste.

(1) The waste classifications in this article shall determine where the waste can be discharged unless the waste does not consist of or contain municipal solid waste (**MSW**) and the discharger establishes to the satisfaction of the RWQCB that a particular waste constituent or combination of constituents presents a lower risk of water quality degradation than indicated by classification according to this article.

(2) Discharges of wastes identified in section 20210 or section 20220 of this article shall be permitted only at Units which have been approved and classified by the RWQCB in accordance with the criteria established in Article 3 of this subchapter, and for which WDRs have been prescribed or waived pursuant to Article 4, Subchapter 3, Chapter 4 of this subdivision (section 21710 et seq.). table 2.1 (of this article) presents a summary of discharge options for each waste category.

(b) **Dedicated Units/Cells For Certain Wastes**—The following wastes shall be discharged only at dedicated Units [or dedicated landfill cells *(e.g., ash monofill cell)*] which are designed and constructed to contain such wastes:

(1) wastes which cause corrosion or decay, or otherwise reduce or impair the integrity of containment structures;

(2) wastes which, if mixed or commingled with other wastes can produce a violent reaction (including heat, pressure, fire or explosion), can produce toxic byproducts, or can produce any reaction product(s) which:

(A) requires a higher level of containment;

(B) is a restricted waste; or

(C) impairs the integrity of containment structures.

(c) **Waste Characterization**—Dischargers shall be responsible for accurate characterization of wastes, including determinations of whether or not wastes will be compatible with containment features and other wastes at a Unit under (b), and whether or not wastes are required to be managed as hazardous wastes under Chapter 11 of Division 4.5 of Title 22 of this code.

(d) **Management of Liquids at Landfills and Waste Piles**—The following requirements apply to discharges of liquids at Class II waste piles and at Class II and Class III landfills, except as otherwise required for MSW landfills by more-stringent state and federal requirements under SWRCB Resolution No. 93-62 (Section 2908, Title 23 of this code) (see 40CFR258.28) *[Note: see also definitions of "leachate" and "landfill gas condensate" in section 20164]*:

(1) [Reserved.];

(2) wastes containing free liquids shall not be discharged to a Class II waste pile. Any waste that contains liquid in excess of the moisture holding capacity of the waste in the Class II landfill, or which contains liquid in excess of the moisture holding capacity as a result of waste management operations, compaction, or settlement shall only be discharged to a surface impoundment or to another Unit with containment features equivalent to a surface impoundment; and

(3) liquids or semi solid waste (i.e., waste containing less than 50 percent solids, by weight), other than dewatered sewage or water treatment sludge as described in section 20220(c), shall not be discharged to Class III landfills. Exceptions may be granted by the RWQCB if the discharger can demonstrate that such discharge will not exceed the moisture holding capacity of the landfill, either initially or as a result of waste management operations, compaction, or settlement, so long as such discharge is not otherwise prohibited by applicable state or federal requirements.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Section 13172, Water Code; Section 43103, Public Resources Code.

20210. SWRCB - Designated Waste. (C15: Section 2522)

Designated waste, as defined in California Water Code section 13173, shall be discharged only at Class I waste management units (for information regarding Class I Units, see Chapter 15, Division 3, Title 23 of this code) or at Class II waste management units which comply with the applicable SWRCB-promulgated provisions of this subdivision and have been approved by the RWQCB for containment of the particular kind of waste to be discharged. Decomposable wastes in this category can be discharged to Class I or II land treatment units.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Section 13172, Water Code; Section 43103, Public Resources Code.

Table 2.1

Table 2.1

20220. SWRCB - Nonhazardous Solid Waste. (C15: Section 2523)

(a) **Definition**—Nonhazardous solid waste means all putrescible and nonputrescible solid, semi solid, and liquid wastes, including garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, demolition and construction wastes, abandoned vehicles and parts thereof, discarded home and industrial appliances, manure, vegetable or animal solid and semi solid wastes and other discarded waste (whether of solid or semi solid consistency); provided that such wastes do not contain wastes which must be managed as hazardous wastes, or wastes which contain soluble pollutants in concentrations which exceed applicable water quality objectives, or could cause degradation of waters of the state (i.e., designated waste).

(b) **Units That Receive**—Except as provided in Section 20200(d) (for liquids), nonhazardous solid waste may be discharged at any classified landfill which is authorized to accept such waste, provided that:

> (1) the discharger shall demonstrate that codisposal of nonhazardous solid waste with other waste shall not create conditions which could impair the integrity of containment features and shall not render designated waste hazardous *(e.g., by mobilizing hazardous constituents)*; and
>
> (2) the discharger shall ensure, to the maximum extent feasible, that the Unit receives only those wastes that are approved for being discharged at that Unit. *[Note: see also CIWMB Section 20870]*

(c) **Dewatered Sludge**—Dewatered sewage or water treatment sludge may be discharged at a Class III landfill under the following conditions, unless DTSC determines that the waste must be managed as hazardous waste:

> (1) the landfill is equipped with a leachate collection and removal system (**LCRS**);
>
> (2) the sludge contains at least 20 percent solids (by weight) if primary sludge, or at least 15 percent solids if secondary sludge, mixtures of primary and secondary sludges, or water treatment sludge; and
>
> (3) a minimum solids to liquid ratio of 5:1 by weight shall be maintained to ensure that the codisposal will not exceed the initial moisture holding capacity of the nonhazardous solid waste. The actual ratio required by the RWQCB shall be based on site specific conditions.

(d) **Ash**—Incinerator ash may be discharged at a Class III landfill unless DTSC determines that the waste must be managed as hazardous waste.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Section 13172, Water Code; Section 43103, Public Resources Code.*

20230. SWRCB - Inert Waste. (C15: Section 2524)

(a) **Defined**—Inert waste is that subset of solid waste that does not contain hazardous waste or soluble pollutants at concentrations in excess of applicable water quality objectives, and does not contain significant quantities of decomposable waste.

(b) **Units That Accept**—Inert wastes do not need to be discharged at classified Units.

(c) **WDRs Optional**—The RWQCB can prescribe individual or general WDRs for discharges of inert wastes.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Section 13172, Water Code; Section 43103, Public Resources Code.

Last updated: May 16, 2006

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Chapter 3 Criteria for All Waste Management Units, Facilities, and Disposal Sites

Subchapter 2. Siting and Design

Article 3. Waste Management Unit, Facility, or Disposal Site Classification and Siting

20240. SWRCB - Classification and Siting Criteria. (C15: section 2530)

(a) **Units and Facilities** —Waste management units (**Units**) shall be classified according to their ability to contain wastes. Containment shall be determined by geology, hydrology, topography, climatology, and other factors relating to the ability of the Unit to protect water quality. A waste management facility can consist of several Units each with a different classification. Classification of Units shall be based on the criteria contained in this article, on field inspections by RWQCB and SWRCB staffs, and on other pertinent information. Information used to classify Units shall be submitted according to the provisions of Article 4, Subchapter 3, Chapter 4 of this subdivision (section 21710 et seq.). Owners or operators of classified Units shall comply with waste discharge requirements (**WDRs**) adopted by the RWQCB.

(b) **Reclassification**—Existing Units shall be reclassified according to applicable criteria in this article, provided that such Units:

> (1) comply with siting criteria for each category of existing Units in section 20250 and section 20260, and summarized in table 3.1 of this article; and
>
> (2) are operating in compliance with section 20080(d).

(c) **Five-Foot Separation** — All new landfills, waste piles, and surface impoundments shall be sited, designed, constructed, and operated to ensure that wastes will be a minimum of five feet (5 ft.) above the highest anticipated elevation of underlying ground water. Existing landfills, waste piles, and surface impoundments shall be operated to ensure that wastes will be a minimum of five feet (5 ft.) above the highest anticipated elevation of underlying ground water. For new and existing land treatment units, the base of the treatment zone shall be a minimum of five feet (5 ft.) above the highest anticipated elevation of underlying ground water and dischargers shall not be entitled to exemption under section 20080(b).

(d) **Unit Foundation —** All engineered structures (including, but not limited to, containment structures) constituting any portion of a Unit shall have a foundation or base capable of providing support for the structures, and capable of withstanding hydraulic pressure gradients to prevent failure due to settlement, compression, or uplift and all effects of ground motions resulting from at least the maximum probable earthquake [for Class III Units (see section 20370)] or the maximum credible earthquake [for Class II Units (see section 20370)], as certified by a registered civil engineer or certified engineering geologist. *[Note: see also section 21750(f)(5).]*

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.*

20250. SWRCB - Class II: Waste Management Units for Designated Waste. (C15: Section 2532)

(a) **General** — Class II waste management units (**Class II Units**) shall be located where site characteristics and containment structures isolate waste from waters of the state. The classification criteria in this section shall be used for reclassification of existing Units at disposal sites approved as Class II 1 under previous versions of these SWRCB regulations, and for existing Units used for treatment or for storage, whether or not classified, provided that no hazardous wastes other than those which DTSC has determined need not be discharged as a hazardous waste) have been discharged at such Units (including discharge at any expansion of such Units).

(b) **Geologic Setting.**

(1) New and existing Class II landfills or waste piles shall be immediately underlain by natural geologic materials which have a hydraulic conductivity of not more than $1\text{x}10^{-6}$ cm/sec (i.e., 1 foot/year) and which are of sufficient thickness to prevent vertical movement of fluid, including waste and leachate, from Units to waters of the state for as long as wastes in such units pose a threat to water quality. Class II units shall not be located where areas of primary (porous) or secondary (rock opening) hydraulic conductivity greater than $1\text{x}10^{-6}$ cm/sec (i.e., 1 foot/year) could impair the competence of natural geologic materials to act as a barrier to vertical fluid movement.

(2) Natural or artificial barriers shall be used to prevent lateral movement of fluid, including waste and leachate.

(3) A liner system which conforms to the requirements of Article 4 of this subchapter with a hydraulic conductivity of not more than $1\text{x}10^{-6}$ cm/sec (i.e., 1 foot/year) shall be used for landfills and waste piles when natural geologic materials do not satisfy the requirements in (b)(1).

(4) Class II surface impoundments are not required to comply with the requirements of (b)(1), but shall have a liner system designed in accordance with the applicable SWRCB-promulgated provisions of Article 4 of this subchapter (Section 20310 et seq.). The RWQCB can allow Class II surface impoundments which are designed and constructed with a double liner system in accordance with that article to use natural geologic materials which comply with (b)(1) for the outer liner.

(5) Land treatment units (**LTUs**) are not required to comply with the requirements of (b). Dischargers who treat or dispose of wastes in LTUs shall demonstrate, prior to application of the waste, that waste can be completely degraded, transformed, or immobilized in the treatment zone. To demonstrate this, prior to the application of waste, the discharger shall operate a test plot for a sufficient period to give the RWQCB a reasonable indication that degradation, transformation, or immobilization will take place in the treatment zone. During the full scale operation of the LTU, soil and soil pore liquid samples shall be taken within the treatment zone to verify that complete degradation, transformation, or immobilization is taking place. The RWQCB shall specify in WDRs the elements of the land treatment program including the dimensions of the treatment zone. The maximum depth of the treatment zone shall not exceed 5 feet from the initial soil surface.

(c) **Flooding** — New and existing Class II Units shall be designed, constructed, operated, and maintained to prevent inundation or washout due to floods with a 100 year return period. MSW landfills are also subject to any more-stringent flood plain and wetland siting requirements referenced in SWRCB Resolution No. 93-62 (i.e., see Section 258.11 and Section 258.12 of 40CFR258).

(d) **Ground Rupture** — New Class II Units, other than LTUs and expansions of existing Class II units, shall have a 200 foot setback from any known Holocene fault. Other units (that are subject to this section) can be located within 200 feet of a known Holocene fault, provided the RWQCB finds that the Unit's containment structures are capable of withstanding ground accelerations associated with the maximum credible earthquake.

(e) **Rapid Geologic Change** — New and existing Class II Units can be located within areas of potential rapid geologic change only if the RWQCB finds that the Unit's containment structures are designed, constructed, and maintained to preclude containment failure. MSW landfills are also subject to any more-stringent unstable area siting requirements referenced in SWRCB Resolution No. 93-62 (i.e., see Section 258.15 and Section 258.16 of 40CFR258).

(f) **Tidal Waves** — New and existing Class II Units may be located in areas subject to tsunamis, seiches, and surges. Other Units may be located within these areas if designed, constructed, and maintained to preclude failure due to such events.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20260. SWRCB - Class III: Landfills for Nonhazardous Solid Waste. (C15: Section 2533)

a) **General** — Class III landfills shall be located where site characteristics provide adequate separation between nonhazardous solid waste and waters of the state. The classification criteria in this section shall be used for reclassification of existing landfills at disposal sites approved as Class II-1 or II-2 (under previous versions of these SWRCB regulations) and any expansions of such landfills.

(b) **Geologic Setting.**

(1) MSW landfills are subject to the SWRCB-promulgated waste containment requirements of this subdivision and of SWRCB Resolution No. 93-62. New Class III and existing Class II-2 landfills shall be sited where soil characteristics, distance from waste to ground water, and of water beneath or adjacent to the landfill. Factors that shall be evaluated include:

factors will ensure no impairment of beneficial uses of surface water or of ground

(A) size of the landfill:

(B) hydraulic conductivity and transmissivity of underlying soils;

(C) depth to ground water and variations in depth to ground water;

(D) background quality of ground water;

(E) current and anticipated use of the ground water; and

(F) annual precipitation.

(2) Where consideration of the factors in (b)(1) indicates that site characteristics alone do not ensure protection of the quality of ground water or surface water, Class III landfills shall be required to have a single clay liner with hydraulic conductivity of $1x10^{-6}$ cm/sec or less.

(c) **Flooding** — New Class III and existing Class II-2 landfills shall be designed, constructed, operated, and maintained to prevent inundation or washout due to floods with a 100 year return period. MSW landfills are also subject to any more-stringent flood plain and wetland siting requirements referenced in SWRCB Resolution No.93-62 (i.e., see Sections 258.11, 258.12, and 258.16 of 40CFR258).

(d) **Ground Rupture** — New Class III and expansions of existing Class II-2 landfills shall not be located on a known Holocene fault. However, existing landfills assigned a Class II-2 designation under previous versions of the SWRCB regulations may be located on a known Holocene fault, provided that the Unit's containment structures are capable of withstanding ground accelerations associated with the maximum probable earthquake (see Section 20370).

(e) **Rapid Geologic Change** — New Class III and unreclassified existing Class II-2 landfills can be located within areas of potential rapid geologic change only if the RWQCB finds that the Unit's containment structures are designed, constructed, and maintained to preclude failure. MSW landfills are also subject to any more-stringent unstable area siting requirements referenced in SWRCB Resolution No. 93-62 (see section 258.15 and Section 258.16 of 40CFR258).

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20270. CIWMB - Location Restrictions: Airport Safety. (T14:Section 17258.10)

(a) Owners or operators of new Municipal Solid Waste Landfill units (MSWLF), existing MSWLF units, and lateral expansions of MSWLF units that are located within 10,000 feet (3,048 meters) of any airport runway end used by turbojet aircraft or within 5,000 feet (1,524 meters) of any airport runway end used by only piston-type aircraft must demonstrate that the units are designed and operated so that the MSWLF unit does not pose a bird hazard to aircraft.

(b) Owners or operators proposing to site new MSWLF units and lateral expansions located within a five-mile radius of any airport runway end used by turbojet or piston-type aircraft must notify the affected airport and the Federal Aviation Administration (**FAA**).

(c) The owner or operator must place the demonstration made pursuant to paragraph (a) of this section in the operating record and notify the EA that it has been placed in the operating record.

(d) Existing MSWLF units that cannot make the demonstration specified in section 20270(a) pertaining to airports must:

(1) close by October 9, 1996, in accordance with section 21110 of this article;

(2) conduct postclosure activities in accordance with section 21110 of this article; and

(3) conduct closure and postclosure activities in accordance with applicable sections of Chapter 4, and Chapter 6, of this Division.

(e) The deadline for closure required by paragraph (a) of this section may be extended up to two years if the owner or operator demonstrates to the CIWMB that:

(1) There is no available alternative disposal capacity; and

(2) There is no immediate threat to human health and the environment.

Note:

Authority cited:
Section 40502, 43020, 43021 Public Resources Code.

Reference:
Section 40508 and 43103, Public Resources Code; and Title 40, Code of Federal Regulations, Section 258.10, and 258.16.

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Chapter 3 Criteria for All Waste Management Units, Facilities, and Disposal Sites

Subchapter 2. Siting and Design

Article 4. SWRCB - Waste Management Unit Construction Standards

20310. SWRCB - General Construction Criteria. (C15: Section 2540)

(a) Class II waste management units (**Class II** "**Units**") shall be designed and constructed to prevent migration of wastes from the Units to adjacent geologic materials, ground water, or surface water, during disposal operations, closure, and the post closure maintenance period. Class II and Class III MSW landfills are also subject to any applicable waste containment system design requirements of SWRCB Resolution No. 93-62 to the extent that such requirements are more stringent than those applicable to a non-MSW Class II or Class III landfill under this subdivision.

(b) Each Class II Unit shall be designed and constructed for the containment of the specific wastes which will be discharged.

(c) Class III landfills shall have containment structures which are capable of preventing degradation of waters of the state as a result of waste discharges to the landfills if site characteristics are inadequate.

(d) For the purposes of this paragraph, the words "new" and "existing" have the same meaning as described in section 20080(d). New landfills, waste piles, and surface impoundments shall comply with the requirements of this article. Existing waste piles and surface impoundments shall be fitted with liners and leachate collection and removal systems as described in section 20330 and section 20340 as feasible. Existing landfills and waste piles shall have interim cover as described in section 20705. Existing landfills, waste piles, and surface impoundments shall be fitted with subsurface barriers as described in section 20360 as needed and feasible, and shall have precipitation and drainage control facilities as described in section 20365. Existing surface impoundments shall comply with section 20375. New and existing land treatment units shall comply with section 20377. All existing Units shall comply with the seismic design criteria in section 20370.

(e) Containment structures shall be designed by, and construction shall be supervised and certified by, a registered civil engineer or a certified engineering geologist. Units shall receive a final inspection and approval of the construction by RWQCB or SWRCB staff before use of the Unit commences.

(f) The discharger shall maintain the integrity of containment structures in spite of normal excavation or fire control work; nevertheless, for fire control work, the discharger can damage containment structures to the extent necessary to control the fire, so long as the discharger promptly repairs such damage after extinguishing the fire. Excavations made as part of discharge operations shall not result in removal of any portion of a containment structure.

(g) **Stability Analysis —** For any portions of the Unit's containment system installed after July 18, 1997, for which the RWQCB has not approved a slope and foundation stability report on or before that date, the discharger shall meet the requirements of section 21750(f)(5).

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

Table 3.1

Table 3.1

Table 4.1

Table 4.1

20320. SWRCB - General Criteria for Containment Structures. (C15: Section 2541)

(a) **Material Properties** — Materials used in containment structures shall have appropriate chemical and physical properties to ensure that such structures do not fail to contain waste because of pressure gradients (including hydraulic head and external hydrogeologic forces), physical contact with the waste or leachate, chemical reactions with soil and rock, climatic conditions, the stress of installation, or because of the stress of daily operation.

(b) **Applicable Permeants** — Hydraulic conductivities specified for containment structures other than cover shall be relative to the fluids, including waste and leachate, to be contained. Hydraulic conductivities specified for final cover shall be relative to water.

(c) **Determining Hydraulic Conductivity** — Hydraulic conductivities shall be determined primarily by appropriate field test methods in accordance with accepted civil engineering practice. The results of laboratory tests with both water and leachate, and field tests with water *(e.g., on the test pad)*, shall be compared to evaluate how the field permeabilities will be affected by leachate. It is acceptable for the discharger to use appropriate compaction tests in conjunction with laboratory hydraulic conductivity tests to determine field permeabilities as long as a reasonable number of field hydraulic conductivity tests are also conducted *(e.g., a sealed double-ring infiltrometer test on the test pad)*.

(d) **Soils Used in Containment Structures** — Earthen materials used in containment structures other than cutoff walls and grout curtains shall consist of a mixture of clay and other suitable fine grained soils which have the following characteristics, and which, in combination, can be compacted to attain the required hydraulic conductivity when installed. Liners made of such materials are referred to as "clay liners" in this subchapter.

> (1) At least 30 percent of the material, by weight, shall pass a No. 200 U.S. Standard sieve.
>
> (2) The materials shall be fine grained soils with a significant clay content and without organic matter, and which is a clayey sand, clay, sandy or silty clay, or sandy clay under a soil classification system having industry-wide use *[e.g., the "SC", "CL", or "CH" soil classes under ASTM Designation: D2487-93 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)]*.

(e) **Synopses** — Construction standards for waste management units other than land treatment are given on table 4.1 and in Figure 4.1.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.*

20323. SWRCB - CQA Plan. (new)

After July 18, 1997, the RWQCB shall require construction for all liner systems and final cover systems to be carried out in accordance with a CQA plan certified by an appropriately registered professional to satisfy the requirements of section 20324. If the RWQCB finds that any construction of the liner system or final cover system was undertaken in the absence of a CQA plan that satisfies the requirements of section 20324, the RWQCB shall require the discharger to undertake any corrective construction needed to achieve such compliance.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.*

20324. SWRCB - CQA Requirements. (T14: Section 17774)

(a) **Performance Standard —** The construction quality assurance (**CQA**) program, including all relevant aspects of construction quality control (**CQC**), shall provide evidence that materials and procedures utilized in the placement of the any containment feature at a waste management unit (**Unit**) will be tested and monitored to assure the structure is constructed in accordance with the design specifications approved by the RWQCB.

(b) **Professional Qualifications.**

> (1) The design professional who prepares the CQA plan shall be a registered civil engineer or certified engineering geologist; and
>
> (2) The construction quality assurance program shall be supervised by a registered civil engineer or certified engineering geologist who shall be designated the CQA officer.

(c) **Reports.**

> (1) The project's CQA report shall address the construction requirements, including any vegetation procedures, set forth in the design plan for the containment system. For each specified phase of construction, this report shall include, but not be limited to:
>
> > (A) a delineation of the CQA management organization, including the chain of command of the CQA inspectors and contractors;
> >
> > (B) a detailed description of the level of experience and training for the contractor, the work crew, and CQA inspectors for every major phase of construction in order to ensure that the installation methods and procedures required in the containment system design will be properly implemented.

(C) a description of the CQA testing protocols for preconstruction, construction, and postconstruction which shall include at a minimum:

1. the frequency of inspections by the operator,

2. the sampling and field testing procedures and equipment to be utilized, and the calibration of field testing equipment,

3. the frequency of performance audits determined by the design professional and examined by the CQA officer,

4. the size, method, location and frequency of sampling, sampling procedures for laboratory testing, the soils or geotechnical laboratory to be used, the laboratory procedures to be utilized, the calibration of laboratory equipment and quality assurance and quality control of laboratory procedures,

5. the pass/fail criteria for sampling and testing methods used to achieve containment system design, and

6. a description of the corrective procedures in the event of test failure.

(d) **Documentation** — Construction quality assurance documentation requirements shall include, at the minimum: reports bearing unique identifying sheet numbers for cross referencing and document control, the date, project name, location, descriptive remarks, the data sheets, inspection activities, and signature of the designated authorities with concurrence of the CQA officer.

(1) **The documentation shall include:**

(A) **Daily Summary Reports** — daily recordkeeping, which shall include preparation of a summary report with supporting inspection data sheets, problem identification and corrective measures reports. Daily summary reports shall provide a chronological framework for identifying and recording all other reports. Inspection data sheets shall contain all observations (i.e., notes, charts, sketches, or photographs), and a record of field and/or laboratory tests. Problem identification and corrective measures reports shall include detailed descriptions of materials and/or workmanship that do not meet a specified design and shall be cross-referenced to specific inspection data sheets where the problem was identified and corrected;

(B) **Acceptance Reports** — all reports shall be assembled and summarized into Acceptance Reports in order to verify that the materials and construction processes comply with the specified design. This report shall include, at a minimum, inspection summary reports, inspection data sheets, problem identification and corrective measures reports;

(C) **Final Documentation** — at the completion of the project, the operator shall prepare a Final Documentation which contains all reports submitted concerning the placement of the containment system. This document shall provide evidence that the CQA plan was implemented as proposed and that the construction proceeded in accordance with design criteria, plans, and specifications. The discharger shall submit copies of the Final Documentation report to the RWQCB as prepared by the CQA officer.

(2) Once construction is complete, the document originals shall be stored by the discharger in a manner that will allow for easy access while still protecting them from any damage. All documentation shall be maintained throughout the postclosure maintenance period.

(e) **Laboratory Testing Requirements.** *[Note: the following (ASTM) standards are available from the American Society of Testing and Materials (**ASTM**), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2929, phone: 610-832-9585.]*

(1) Analysis of earthen materials shall be performed prior to their incorporation into any containment system component. Representative samples for each layer within the containment system shall be evaluated. The following minimum laboratory testing procedures shall be performed:

(A) ASTM Designation: D 1557 91 [1/91], "Laboratory Compaction Characteristics of Soil Using Modified Effort (2,700 kN-m/m3)" which is incorporated by reference;

(B) ASTM Designation: D 422 63 (Reapproved) [9/90], "Standard Method for Particle Size Analysis of Soils," which is incorporated by reference; and

(C) ASTM Designation: D 2487 93 [11/93], "Standard Classification of Soils for Engineering Purposes," which is incorporated by reference.

(2) In addition to the tests listed in (e and f), the following minimum laboratory tests shall be performed on low-hydraulic-conductivity layer components constructed from soil:

(A) ASTM Designation: D 4318 93 [11/93], "Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils," which is incorporated by reference; and

(B) United States Environmental Protection Agency (**USEPA**) Test Method 9100 [Approved 9-86], "Triaxial-Cell Method with Back Pressure," which is incorporated by reference.

(f) **Field Testing Requirements** — The following minimum field test procedure shall be performed for each layer in the containment system: ASTM Designation: D 2488 93 [9/93], Standard Practice for Description and Identification of Soils (Visual Manual Procedure), which is incorporated by reference.

(g) **Test Fill Pad Requirements** — Before installing the compacted soil barrier layer component of a final cover system, or the compacted soil component of a liner system, the operator shall accurately establish the correlation between the design hydraulic conductivity and the density at which that conductivity is achieved. To accomplish this the operator shall:

(1) provide a representative area for a test on any compacted foundation and low-hydraulic-conductivity layers. The following minimum testing procedures shall be performed:

(A) the test pad foundation and, for final covers, the barrier layers shall be compacted with the designated equipment to determine if the specified density/moisture-content/ hydraulic-conductivity relationships determined in the laboratory can be achieved in the field with the compaction equipment to be used and at the specified lift thickness;

(2) perform laboratory tests as specified in subsection (e); and

(3) perform field tests as specified in subsection (f). The discharger shall perform hydraulic conductivity tests in the test area under saturated conditions by using the standard test method ASTM Designation: D 3385 94 [9/94], "Standard Test Method for Infiltration Rate of Soils in Field Using Double Ring Infiltrometer," which is incorporated by reference, for vertical hydraulic conductivity measurements. A sufficient number of tests shall be run to verify the results. Other methods that provide an accurate and precise method of measuring field hydraulic conductivity may be utilized as approved by the RWQCB.

(4) Correlations between laboratory tests and test pad results shall be established for each of the various types of fill materials and blends to be used in construction of the actual cover.

(h) **Earthen Material Requirements.**

(1) The following minimum tests shall include, but not be limited to:

(A) Laboratory tests as specified in (e); and

(B) Field tests as specified in subsections (f and g).

(2) The following minimum testing frequencies shall be performed:

(A) Four (4) field density tests shall be performed for each 1,000 cubic yards of material placed, or at a minimum of four (4) tests per day;

(B) Compaction curve data (ASTM Designation: D 1557 91) graphically represented, and Atterberg limits (ASTM Designation: D 4318 93) shall be performed on the barrier layer material once a week and/or every 5,000 cubic yards of material placed;

(C) For field hydraulic conductivity tests, representative samples shall be performed on barrier layer material;

1. The frequency of testing may be increased or decreased, based on the pass/failure status of previous tests, as approved by the RWQCB.

2. Field infiltration tests shall be performed for the duration necessary to achieve steady conditions for the design hydraulic conductivity.

3. The following interpretive equation shall be used to determine the design hydraulic conductivity:

The infiltration rate (**I**) is defined as:

$$\mathbf{I = Q/(tA)}$$

where:

Q = volume of flow;

t = interval of time corresponding to flow Q; and

A = area of the ring;

then the hydraulic conductivity (**k**) can be calculated from Darcy's law as follows:

$$\mathbf{k = I/i}$$

where:

I = infiltration rate; and

i = hydraulic gradient.

(i) **Geosynthetic Membrane Requirements.**

(1) Performance requirements for the geosynthetic membrane include, but are not limited to, the following:

(A) a need to limit infiltration of water, to the greatest extent possible;

(B) a need to control landfill gas emissions;

(C) for final covers, mechanical compatibility with stresses caused by equipment traffic, and the result of differential settlement of the waste over time; and

(D) for final covers, durability throughout the postclosure maintenance period.

(2) **Minimum Criteria —** The minimum construction quality assurance criteria to ensure that geosynthetic membranes will meet or exceed all design specifications shall include, but not be limited to:

(A) Preconstruction quality control program:

1. inspection of the raw materials (e.g., density, melt flow index, percent carbon Black);

2. manufacturing operations and finished product specifications (e.g., thickness, puncture resistance, multi axial stress/strain tests),

3. fabrication operations (e.g., factory seaming);

4. observations related to transportation, handling, and storage of the geosynthetic membrane; and

5. inspection of foundation preparation;

(B) Construction activities:

1. the geosynthetic membrane shall have thickness strength sufficient to withstand the stresses to which it shall be subjected, including shear forces, puncture from rocks or, for final covers, penetration from roots.

2. inspection of geosynthetic membrane placement (e.g., trench corners, monitoring systems).

3. seaming of the material; and

4. installation of anchors and seals;

(C) **Postconstruction Activity** — postconstruction activity includes checking for material and placement imperfections in the installed geosynthetic membrane. Imperfections that jeopardize the integrity of the membrane's function as an impermeable barrier (i.e., pin holes, rips, creases created during placement) shall be repaired to the original manufacturer's specifications and reinspected by the CQA officer; and

(D) **Evaluation** — evaluation of the personnel and equipment to be used to install and inspect the geosynthetic membrane, and pass/fail criteria and corrective procedures for material and installation procedures shall be specified as required in (c).

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20330. SWRCB - Liners. (C15: Section 2542)

(a) **Performance Standard** — Liners shall be designed and constructed to contain the fluid, including landfill gas, waste, and leachate, as required by Article 3 of this subchapter (Section 20240 et seq., and section 20310).

(b) **Clay Liners** — Clay liners for a Class II Unit shall be a minimum of 2 feet thick and shall be installed at a relative compaction of at least 90 percent. For a Class III landfill, a clay liner, if required, shall be a minimum of 1 foot thick and shall be installed at a relative compaction of at least 90 percent. For MSW landfills subject to the liner requirements in the federal MSW regulations of 40CFR258, after the Federal Deadline for liners at that Unit, the requirements of this paragraph are superseded by those of SWRCB Resolution No. 93-62 for all portions of the Unit outside the Existing Footprint.

(c) **FMLs** — Flexible membrane liners ("**FMLs**," or synthetic liners) shall have a minimum thickness of 40 mils (i.e., 0.040"). For an MSW landfill subject to the liner requirements in the federal MSW regulations (40CFR258), after the Federal Deadline for liners at that Unit, the requirements of this paragraph are superseded by those of SWRCB Resolution No. 93-62 for all portions of the Unit outside the Existing Footprint.

(d) **Lined Area** — Liners shall be installed to cover all natural geologic materials (at the Unit) that are likely to be in contact with waste (including landfill gas or leachate).

(e) **S.I. With Replaceable Liner** — A Class II surface impoundment may have a single clay liner with a hydraulic conductivity of 1×10^{-6} cm/sec (i.e., 1 foot/year) or less if the liner is removed or replaced before the last 25 percent (minimum 1 foot thickness) of the liner is penetrated by fluid, including waste or leachate. The method used to determine seepage velocity shall be included with the calculations of liner penetration.

Note:

> ***Authority cited:***
> *Section 1058, Water Code;*
>
> ***Reference:***
> *Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.*

20340. SWRCB - Leachate Collection and Removal Systems (LCRS). [C15: Section 2543 // T14: Section 17781(b)(2) (d)(1)]

(a) **Basic LCRS Design —** Leachate collection and removal systems (**LCRS**) are required for Class II landfills and surface impoundments, and for Class III landfills which have a liner or which accept sewage or water treatment sludge. The LCRS shall be installed directly above underlying containment features for landfills and waste piles, and installed between the liners for surface impoundments. LCRS requirements are summarized on table 4.1. Class II landfills and waste piles which contain only dry wastes (not including nonhazardous solid waste and decomposable waste) may be allowed to operate without an LCRS if the discharger demonstrates, based on climatic and hydrogeologic conditions, that leachate will not be formed in, or migrate from, the Unit; nevertheless, for a Class II or Class III MSW landfill, after the Federal Deadline for installing liners at that Unit, the LCRS requirements of SWRCB Resolution No. 93-62 apply to all portions outside of the Unit's Existing Footprint.

(b) **Placement —** Except as otherwise provided in (e or f), where an LCRS is used, it shall be installed immediately above the liner (except in the case of a surface impoundment), and between the inner and outer liner of a double liner system, and shall be designed, constructed, maintained, and operated to collect and remove twice the maximum anticipated daily volume of leachate from the Unit.

(c) **Head Buildup —** The RWQCB shall specify design and operating conditions in WDRs to ensure that there is no buildup of hydraulic head on the liner. The depth of fluid in the collection sump shall be kept at the minimum needed to ensure efficient pump operation.

(d) **Clogging —** LCRSs shall be designed and operated to function without clogging through the scheduled closure of the Unit and during the post closure maintenance period. The systems shall be tested at least annually to demonstrate proper operation. The results of the tests shall be compared with earlier tests made under comparable conditions.

(e) **Standard LCRS —** LCRSs shall consist of a permeable subdrain layer which covers the bottom of the Unit and extends as far up the sides as possible, (i.e., blanket type) except as provided in (f). The LCRS shall be of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying wastes, waste cover materials, and by any equipment used at the Unit.

(f) **Alternative LCRS —** Except as otherwise required for MSW landfills, under SWRCB Resolution No. 93-62, if a Class III landfill is required to have an artificial liner and receives only permeable waste that allows free drainage of percolating fluid, the RWQCB can allow the use of a dendritic LCRS which underlies less than 100 percent of the waste; in this type of LCRS system, only wastes which have an hydraulic conductivity which approximates that of subdrain material, and which will remain permeable throughout the active life and post closure maintenance period of the landfill, shall be placed adjacent to the liner. Furthermore, to prevent ponding, when using this type of LCRS, all portions of the liner not overlain by a portion of the subdrain system shall be sloped towards the subdrain so that ponding is minimized and leachate is removed as quickly as possible from the base of the landfill.

(g) **Leachate Handling —** Except as otherwise provided under SWRCB Resolution No. 93-62 (for MSW landfills subject to 40CFR258.28), collected leachate shall be returned to the Unit(s) from which it came or discharged in another manner approved by the RWQCB. Collected leachate can be discharged to a different Unit only if:

(1) the receiving Unit has an LCRS, contains wastes which are similar in classification and characteristics to those in the Unit(s) from which leachate was extracted, and has at least the same classification (under Article 3 of this subchapter) as the Unit(s) from which leachate was extracted;

(2) the discharge to a different Unit is approved by the RWQCB;

(3) the discharge of leachate to a different Unit shall not exceed the moisture holding capacity of the receiving unit, and shall comply with section 20200(d).

(h) **Leachate Production Rate —** After July 18, 1997, for a landfill equipped with an LCRS, the discharger shall note, as a part of each regularly scheduled monitoring report [under Article 1, Subchapter 3, Chapter 3 of this division (section 20380 et seq.)], the total volume of leachate collected each month since the previous monitoring report.

Note:

Authority cited:
Section 1058, Water Code;

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20360. SWRCB - Subsurface Barriers. (C15: Section 2545)

(a) Subsurface barriers are cutoff walls or grout curtains which are used in conjunction with natural geologic materials to assure that lateral hydraulic conductivity standards specified in Article 3 of this subchapter are satisfied. Paragraphs (b) and (c) specify conditions under which cutoff walls and grout curtains, respectively, are used.

(b) **Cutoff walls.**

(1) Cutoff walls are required at Class II Units where there is potential for lateral movement of fluid, including waste or leachate, and the hydraulic conductivity of natural geologic materials is used for waste containment in lieu of a liner. Cutoff walls shall be installed at Class III landfills as required by the RWQCB.

(2) Cutoff walls shall be:

(A) a minimum of two feet thick for clay materials; or

(B) a minimum of 40 mils (i.e., 0.040") thick for synthetic materials; and

(C) regardless of the option under (b)(2)(A or B), shall be keyed a minimum of five feet into natural geologic material which satisfies the applicable hydraulic conductivity requirements in Article 3 of this subchapter.

(3) If cutoff walls are used, excavations for Units shall be keyed into natural geologic materials which satisfy applicable hydraulic conductivity requirements in Article 3 of this Subchapter.

(4) At closure of a waste pile or surface impoundment, all contaminated natural geologic materials present between the cutoff wall(s) and the waste shall be removed and disposed of at an authorized location, or the Unit shall be closed as a landfill.

(5) Cutoff walls shall have fluid collection systems installed upgradient of the structure. The systems shall be designed, constructed, operated, and maintained to prevent the buildup of hydraulic head against the structure. The collection system shall be inspected regularly, and accumulated fluid shall be removed.

(c) **Grout Curtains.**

(1) Grout curtains may be used as needed to prevent lateral waste movement through fractures in natural geologic materials that otherwise satisfy applicable hydraulic conductivity requirements in Article 3 of this Subchapter. Only fractures that are at or near the surface and are of limited vertical extent may be grouted.

(2) The acceptability of grout curtains for a Unit shall include consideration of:

(A) depth and nature of fracturing; and

(B) fracture orientation.

(3) Grout characteristics shall not be adversely affected by fluid, including waste and leachate, or natural conditions.

(4) Optimum grouting pressure and the placement of grout holes shall be determined by test grouting.

Note:

Authority cited:
Section 1058, Water Code;

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20365. SWRCB - Precipitation and Drainage Controls. [C15: Section 2546 // T14: §17778(e), (f)(1), (g), & (j)]

(a) **General** — Units and their respective containment structures shall be designed and constructed to limit, to the greatest extent possible, ponding, infiltration, inundation, erosion, slope failure, washout, and overtopping under the precipitation conditions specified in table 4.1 (of this article) for each class of waste management unit (Unit). *[Note: see also section 21090(b)(1).]*

(b) **Undiverted Precipitation** — Precipitation on landfills or waste piles which is not diverted by covers or drainage control systems shall be collected and managed through the leachate collection and removal system, which shall be designed and constructed to accommodate precipitation conditions specified in table 4.1 of this article or each class Unit.

(c) **Performance Standards** — Diversion and drainage facilities shall be designed, constructed, and maintained:

(1) to accommodate the anticipated volume of precipitation and peak flows from surface runoff under the precipitation conditions specified in Table 4.1 of this article for each class of Unit;

(2) to effectively divert sheet flow runoff laterally, or via the shortest distance, into the drainage and collection facilities;

(3) to prevent surface erosion through the judicious use of:

(A) energy dissipators where required to decrease the velocity of runoff; and

(B) slope protection and other erosion control measures;

(4) to control and intercept run-on, in order to isolate uncontaminated surface waters from water that might have come into contact with waste;

(5) to take into account:

(A) for closed Units and for closed portions of Units, the expected final contours of the closed Unit, including its planned drainage pattern;

(B) for operating portions of Units other than surface impoundments, the Unit's drainage pattern at any given time;

(C) the possible effects of the Unit's drainage pattern on and by the regional watershed;

(D) the design capacity of drainage systems of downstream and adjacent properties by providing for the gradual release of retained water downstream in a manner which does not exceed the expected peak flow rate at the point of discharge if there were no waste management facility; and

(6) to preserve the system's function. Therefore, the discharger shall periodically remove accumulated sediment from the sedimentation or detention basins as needed to preserve the design capacity of the system.

(d) **Maintain Capacity** — Collection and holding facilities associated with precipitation and drainage control systems shall be emptied immediately following each storm or otherwise managed to maintain the design capacity of the system.

(e) **Divert Drainage** — Surface and subsurface drainage from outside of a Unit shall be diverted from the Unit.

(f) **Resist Erosion from Design Storm** — Cover materials shall be graded to divert precipitation from the Unit, to prevent ponding of surface water over wastes, and to resist erosion as a result of precipitation with the return frequency specified in table 4.1 (of this article) for each class of Unit, unless, for a landfill, the CIWMB/EA requires (for protection of public health and safety) that the design be capable of resisting erosion resulting from a longer return interval storm [see Section 21150(b)]. Any drainage layer in the final cover shall be designed and constructed to intersect with the final drainage system for the Unit in a manner promoting free drainage from all portions of the drainage layer.

Note:

Authority cited:

Section 1058, Water Code;

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20370. SWRCB - Seismic Design. (C15: Section 2547)

(a) Class II Units shall be designed to withstand the maximum credible earthquake (**MCE**) without damage to the foundation or to the structures which control leachate, surface drainage, or erosion, or gas. Class III Units shall be designed to withstand the maximum probable earthquake (**MPE**) without damage to the foundation or to the structures which control leachate, surface drainage, or erosion, or gas. *[Note: see also submittal requirements under section 21750(f)(5)]*

Note:

Authority cited:
Section 1058, Water Code;

Reference:
Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.

20375. SWRCB - Special Requirements for Surface Impoundments. (C15: Section 2548)

(a) **Freeboard —** Surface impoundments shall have sufficient freeboard to accommodate seasonal precipitation and the design storm specified in table 4.1 of this article, but in no case less than 2 feet (measured vertically, from the water surface up to the point on the surrounding lined berm, or dike, having the lowest elevation), and shall be designed and constructed to prevent overtopping as a result of wind conditions likely to accompany such precipitation conditions. The RWQCB can allow a freeboard of less than 2 feet at surface impoundments located on the interior portions of a waste management facility where:

(1) these interiormost impoundments are designed such that potential overflows would be reliably conveyed by gravity flow and discharged to other surface impoundments having adequate capacity to receive such diversion without exceeding their respective freeboard limitations;

(2) the operation implements a properly developed water balance plan; and

(3) the facility is provided with a fail safe emergency retention area solely for the purpose of containing wastes due to surface impoundment failures.

(b) **Operation Plan —** An operation plan shall be submitted to the RWQCB which will provide operation levels and waste input quantities permitted each month based on anticipated precipitation and on past precipitation conditions for the year.

(c) **Fail-Safe —** Direct pipeline discharge to surface impoundments shall be either equipped with devices or shall have fail safe operating procedures to prevent overfilling. Discharges shall be stopped in the event of any containment system failure which causes a threat to water quality.

(d) **Unauthorized Discharges —** There shall be no discharge from a surface impoundment except as authorized by WDRs.

(e) **Scour Protection —** Surface impoundments shall be designed and constructed to prevent scouring of containment structures at points of discharge into the impoundments and by wave action at the waterline.

(f) **Liner Inspections** — All visible portions of synthetic liners shall be inspected weekly until all free liquid is removed from the surface impoundment as part of closure pursuant to section 21400(a). If, during the active life of the impoundment, the wastes are removed and the bottom of the impoundment is cleaned down to the liner, an inspection shall be made of the bottom of the liner prior to refilling of the impoundment.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.*

20377. SWRCB - Special Requirements for Land Treatment Units (LTUs). (C15: Section 2549)

(a) **General** — Dischargers operating LTUs shall comply with the general criteria specified in Section 20320(a & d), with the precipitation and drainage controls specified in Section 20365, and with the seismic design criteria in Section 20370.

(b) **Performance Standard** — Dischargers shall design, construct, operate, and maintain LTUs to maximize the degradation, transformation, and immobilization of waste constituents in the treatment zone. Dischargers shall design, construct, operate, and maintain units in accord with all design and operating conditions that were used in treatment demonstrations under Section 20250.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172 and 13360, Water Code; Section 43103, Public Resources Code.*

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Subchapter 4
Subchapter 5

Chapter 3 Criteria for All Waste Management Units, Facilities, and Disposal Sites

Subchapter 3. Water Monitoring

Article 1. SWRCB - Water Quality Monitoring and Response Programs for Solid Waste Management Units

20380. SWRCB - Applicability. (C15: Section 2550.0)

(a) The regulations in this article apply to owners or operators of facilities that treat, store, or dispose of waste at waste management units. The owner or operator of a surface impoundment, waste pile, landfill, or land treatment unit that receives or has received waste (hereinafter referred to as "**waste management units**," or "**Units**") that is subject to the SWRCB-promulgated requirements of this division, pursuant to sections 20080 and 20090 shall comply with the provisions of this article for purposes of detecting, characterizing, and responding to releases to ground water, surface water, or the unsaturated zone. Furthermore, section 20400 of this article also applies to all determinations of alternative cleanup levels for unpermitted discharges to land of solid waste, pursuant to & III.G. of SWRCB Resolution No. 92-49 [Section 2550.4 of Title 23 of this code serves a similar function for unpermitted discharges to land of hazardous waste].

(b) **Known or Reasonably Foreseeable Release —** In accordance with applicable requirements of sections 22220-22222, waste discharge requirements (**WDRs**) for a Unit subject to this section shall contain a provision which requires the discharger to obtain and maintain assurances of financial responsibility for initiating and completing corrective action for all known or reasonably foreseeable releases from the Unit.

(c) [Reserved]

(d) **Apply Unless Clean-Closed —** The regulations under this article apply during the Unit's active life and closure period. After closure of the Unit, the regulations in this article apply during the post closure maintenance period of the Unit and during any compliance period under section 20410 of this article, unless:

> (1) the Unit has been in compliance with the water quality protection standard ("**Water Standard**" of section 20390) for a period of three consecutive years; and
>
> (2) **Clean-Closure —** all waste, waste residues, contaminated containment system components, contaminated subsoils, and all other contaminated materials are removed or decontaminated at closure, pursuant to: section 21090(f), for landfills; section 21400(b)(1), for surface impoundments; or section 21410(a)(1), for waste piles.

(e) **Allowable Engineered Alternatives —** In considering a monitoring proposal by the discharger, the RWQCB can allow an engineered alternative for any of the prescriptive standards in this article so long as the RWQCB:

> (1) finds that each engineered alternative meets the requirements of section 20080 (b & c);
>
> (2) finds, for each applicable program under section 20385, that the

discharger's proposed monitoring-data procurement and analysis methods achieve the program's respective goals, including:

(A) for a detection monitoring program, the goals articulated in section 20420(b);

(B) for an evaluation monitoring program, the goals articulated in section 20425(a)(2); and

(C) for a corrective action program, the goals articulated in section 20430(b);

(3) requires ground water monitoring at least annually at disposal Units and at Units that will be used for five or more years for waste treatment or storage.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172 and 13267, Water Code; Section 43103, Public Resources Code.

20385. SWRCB - Required Programs. (C15: Section 2550.1)

(a) **Monitoring Programs & their Respective Triggers —** A discharger subject to this article shall conduct a monitoring and response program, approved by the RWQCB, for each Unit at the facility as follows:

(1) **Detection Monitoring (default) —** The discharger shall institute a detection monitoring program (under section 20420) except as required below under (a)(2-4);

(2) **Evaluation Monitoring (trigger #1) —** The discharger shall institute an evaluation monitoring program (under section 20425) whenever there is "**measurably significant**" (see section 20164) evidence of a release from the Unit during a detection monitoring program [under section 20420
(g or i)];

(3) **Evaluation Monitoring (trigger #2) —** The discharger shall institute an evaluation monitoring program (under section 20425) whenever there is significant physical evidence of a release from the Unit. Significant physical evidence of a release includes unexplained volumetric changes in surface impoundments, unexplained stress in biological communities, unexplained changes in soil characteristics, visible signs of leachate migration, and unexplained water table mounding beneath or adjacent to the Unit and any other change to the environment that could reasonably be expected to be the result of a release from the Unit; and

(4) **Corrective Action —** The discharger shall institute a corrective action program under section 20430 of this article when the RWQCB determines (pursuant to section 20425) that the assessment of the nature and extent of the release and the design of a Corrective Action Program have been satisfactorily completed and the RWQCB approves the application for an amended report of waste discharge for corrective action submitted by the discharger during an evaluation monitoring program [pursuant to section 20425(d)].

(b) **Preparation for Other Programs —** The RWQCB shall specify in the WDRs the specific type or types of monitoring programs required and the specific elements of each monitoring and response program. For each Unit, the RWQCB shall require one or more of the programs identified in (a) that is appropriate for the prevailing state of containment at the Unit, and shall specify the circumstances under which each of the programs will be required. In deciding whether to require the discharger to be prepared to institute a particular program, the RWQCB shall consider the potential adverse effects on human health or the environment that might occur before final administrative action on an amended report of waste discharge to incorporate such a program could be taken.

(c) **Concurrent Detection Monitoring Program, Where Necessary** — In conjunction with an evaluation monitoring program or a corrective action program, the discharger shall continue to conduct a detection monitoring program as necessary to provide the best assurance of the detection of subsequent releases from the Unit.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, 13267, and 13304 Water Code; Section 43103, Public Resources Code.

20390. SWRCB - Water Quality Protection Standard (Water Standard). (C15: Section 2550.2)

(a) **Components & Duration** — For each Unit, the RWQCB shall establish a water quality protection standard (**Water Standard**) in the WDRs. This Water Standard shall consist of the list of constituents of concern (under section 20395), the concentration limits (under section 20400), and the Point of Compliance and all Monitoring Points (under section 20405). This Water Standard shall apply during the active life of the Unit, the closure period, the post closure maintenance period, and during any compliance period (under section 20410).

(b) **Program-Specific Water Standards** — If a discharger is conducting a detection monitoring program in conjunction with a corrective action program for a Unit [pursuant to section 20385(c)], the RWQCB may establish separate Water Standards for each program.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, 13267, and 13304, Water Code; Section 43103, Public Resources Code.

20395. SWRCB - Constituents of Concern (COCs). (C15: Section 2550.3)

(a) **COCs** — For each Unit, the RWQCB shall specify in the WDRs the Constituents of Concern (COCs) to which the Water Standard (under section 20390) applies. The COC list shall include all waste constituents, reaction products, and hazardous constituents that are reasonably expected to be in or derived from waste contained in the Unit.

(b) **MSW COCs** — For MSW landfills, the COC list shall include all constituents mandated under SWRCB Resolution No. 93-62.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.

20400. SWRCB - Concentration Limits. (C15: Section 2550.4)

[Note: The special applicability of this section is described in section 20380(a); see also section 20080(a).]

(a) **Proposal of Concentration Limits** — For each Constituent of Concern (**COC**) specified pursuant to section 20395 (or for a solid waste constituent that is addressed by a cleanup and abatement action taken pursuant to SWRCB Resolution No. 92-49), the discharger shall propose one of the following for each medium (under section 20415, including ground water, surface water, and the unsaturated zone) monitored pursuant to section 20415 of this article:

(1) **Background Value** — a concentration limit not to exceed the background value of that constituent as determined pursuant to section 20415(e)(10)(A);

(2) **Value Redetermined Each Time** — that the WDRs include a statement that, at any given time, the concentration limit for that COC will be equal to the background value of that constituent, as determined pursuant to section 20415(e)(10)(B); or

(3) **CLGBC** — a concentration limit greater than background (**CLGB**) established pursuant to this section for a corrective action program.

(b) **Adoption of Concentration Limits** — The RWQCB shall review the proposed concentration limits and statements and shall approve, modify, or disapprove each proposed limit and each proposed statement. Upon final approval by the RWQCB, each concentration limit and each statement shall be specified in WDRs. The RWQCB shall approve more than one concentration limit for different Monitoring Points in the same medium only if:

(1) more than one background condition exists within a particular medium;

(2) the statistical method approved for a constituent uses intra well comparisons procedures; or

(3) CLGBs have been established for a corrective action program at the Monitoring Points in the zone affected by a release from the Unit.

(c) **Establishing a CLGB** — For a corrective action program, the RWQCB shall establish a CLGB [under (a)(3)] only if the RWQCB finds that it is technologically or economically infeasible to achieve the background value for that constituent and that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the CLGB is not exceeded. In making this finding, the RWQCB shall consider the factors specified in (d), the results of the engineering feasibility study submitted pursuant to section 20425(c), data submitted by the discharger pursuant to section 20425(d)(2) to support the proposed CLGB, public testimony on the proposal, and any additional data obtained during the evaluation monitoring program.

(d) **Considerations** — In establishing a CLGB for a constituent of concern, the RWQCB shall consider the following factors:

(1) potential adverse effects on ground water quality and beneficial uses, considering:

(A) the physical and chemical characteristics of the waste in the Unit;

(B) the hydrogeological characteristics of the facility and surrounding land;

(C) the quantity of ground water and the direction of ground water flow;

(D) the proximity and withdrawal rates of ground water users;

(E) the current and potential future uses of ground water in the area;

(F) the existing quality of ground water, including other sources of contamination or pollution and their cumulative impact on the ground water quality;

(G) the potential for health risks caused by human exposure to waste constituents;

(H) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(I) the persistence and permanence of the potential adverse effects; and

(2) potential adverse effects on surface water quality and beneficial uses, considering:

(A) the volume and physical and chemical characteristics of the waste in the Unit;

(B) the hydrogeological characteristics of the facility and surrounding land;

(C) the quantity and quality of ground water and the direction of ground water flow;

(D) the patterns of precipitation in the region;

(E) the proximity of the Unit to surface waters;

(F) the current and potential future uses of surface waters in the area;

(G) the existing quality of surface water including other sources of contamination or pollution and the cumulative impact on surface water quality;

(H) the potential for health risks caused by human exposure to waste constituents;

(I) the potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents; and

(J) the persistence and permanence of the potential adverse effects.

(e) **CLGB Ceiling —** In no event shall a CLGB for a constituent of concern exceed the lowest concentration that the discharger demonstrates and the RWQCB finds is technologically and economically achievable. No provision of this section shall be taken to allow a CLGB for a constituent of concern to exceed the maximum concentration that would be allowed under other applicable statutes or regulations [e.g., Maximum Concentration Limits established under the federal Safe Drinking Water Act (P.L. 93 523, codified as Subchapter XII of the Public Health Service Act at 42 USC 300f, et. seq.; regulations establishing MCL's are located in 40 CFR Part 141, Subpart B), etc.].

(f) **Receptor Location —** For ground water, in evaluating risk pursuant to (d) to any biological receptor, the risk shall be evaluated as if exposure would occur at the Point of Compliance.

(g) **Additivity —** Proposals for CLGBs shall include a demonstration that the aggregate of hazardous constituents in the environment will not result in excessive exposure to a sensitive biological receptor. In the absence of scientifically valid data to the contrary, theoretical risks from chemicals associated with the release from the Unit shall be considered additive across all media of exposure, and shall be considered additive for all chemicals having similar toxicological effects or having carcinogenic effects.

(h) **Applicability —** A CLGB may only be applied during corrective action, or during detection monitoring following corrective action, at Monitoring Points at which "measurably significant" (see section 20164) evidence of the release has been determined.

(i) **Decreasing the CLGB —** When a detection monitoring program incorporating a CLGB is reinstated after a corrective action program has been terminated, each CLGB shall be re evaluated during each review of WDRs or at least every five years. If the RWQCB, upon re evaluation, determines that the concentration of a constituent of concern in ground water, surface water, or the unsaturated zone is lower than its associated concentration limit by a "measurably significant" (see section 20164) amount, the concentration limit for that constituent shall be lowered to reflect current water quality.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.

20405. SWRCB - Monitoring Points and the Point of Compliance. (C15: Section 2550.5)

(a) For each Unit, the RWQCB shall specify in the WDRs the Point of Compliance at which the Water Standard (of section 20390) applies. The Point of Compliance is a vertical surface located at the hydraulically downgradient limit of the Unit that extends through the uppermost aquifer underlying the Unit. For each Unit, the RWQCB shall specify Monitoring Points (as defined in section 20164) along the Point of Compliance, and shall specify additional Monitoring Points at locations determined pursuant to section 20415(b-d) at which the Water Standard under section 20390 applies and at which monitoring shall be conducted.

(b) If the facility contains contiguous Units and monitoring along a shared boundary would impair the integrity of a containment or structural feature of any of the Units, the Point of Compliance may be located at the hydraulically downgradient limit of an area described by an imaginary line along the outer boundary of the contiguous Units. This provision only applies to contiguous Units that have operated or have received all permits necessary for construction and operation before 7-1-91.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.*

20410. SWRCB - Compliance Period. (C15: Section 2550.6)

(a) The RWQCB shall specify in WDRs a compliance period for each Unit. The compliance period is the number of years equal to the active life of the Unit (including any waste management activity prior to the adoption of the WDRs) plus the closure period. The compliance period is the minimum period of time during which the discharger shall conduct a water quality monitoring program subsequent to a release from the Unit.

(b) The compliance period begins anew each time the discharger initiates an evaluation monitoring program (under section 20425).

(c) If the discharger is engaged in a corrective action program at the scheduled end of the compliance period specified under (a), the compliance period shall be extended until the discharger can demonstrate that the Unit has been in continuous compliance with its Water Standard (under section 20390) for a period of three consecutive years.

Note:

> ***Authority cited:***
> *Section 1058, Water Code.*
>
> ***Reference:***
> *Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.*

20415. SWRCB - General Water Quality Monitoring and System Requirements. [C15: Section 2550.7 // T15: Section 17783.5(d)]

(a) The discharger shall comply with the requirements of this section for any water quality monitoring program developed to satisfy section 20420, section 20425, or section 20430 of this article.

(b) **Ground Water Monitoring System.**

> (1) **General —** Except as provided under (e)(3), the discharger shall establish a ground water monitoring system for each Unit. This ground water monitoring system shall include:
>
> > (A) **For All Programs —** for all monitoring and response programs, a sufficient number of Background Monitoring Points (as defined in section 20164) installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water that has not been affected by a release from the Unit;
> >
> > (B) **For DMP —** for a detection monitoring program under section 20420:
> >
> > > 1. a sufficient number of Monitoring Points (as defined in section 20164) installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water passing the Point of Compliance and to allow for the

detection of a release from the Unit;

2. a sufficient number of Monitoring Points installed at additional locations and depths to yield ground water samples from the uppermost aquifer to provide the best assurance of the earliest possible detection of a release from the Unit;

3. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from portions of the zone of saturation, including other aquifers, not monitored pursuant to (b)(1)(B)1. and (b)(1)(B) 2., to provide the best assurance of the earliest possible detection of a release from the Unit;

4. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from zones of perched water to provide the best assurance of the earliest possible detection of a release from the Unit; and

5. Monitoring Point locations and depths that include the zone(s) of highest hydraulic conductivity in each ground water body monitored pursuant to this subsection [i.e., under (b), inclusive].

(C) **For EMP** — for an evaluation monitoring program under section 20425:

1. a sufficient number of Monitoring Points installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water passing the Point of Compliance and at other locations in the uppermost aquifer to provide the data needed to evaluate changes in water quality due to the release from the Unit;

2. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from portions of the zone of saturation, including other aquifers, not monitored pursuant to (b)(1)(C)1., to provide the data needed to evaluate changes in water quality due to the release from the Unit; and

3. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from zones of perched water to provide the data needed to evaluate changes in water quality due to the release from the Unit; and

(D) **For CAP** — for a corrective action program under section 20430:

1. a sufficient number of Monitoring Points installed at appropriate locations and depths to yield ground water samples from the uppermost aquifer that represent the quality of ground water passing the Point of Compliance and at other locations in the uppermost aquifer to provide the data needed to evaluate the effectiveness of the corrective action program;

2. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from portions of the zone of saturation, including other aquifers, not monitored pursuant to (b)(1)(D)1., to provide the data needed to evaluate the effectiveness of the corrective action program; and

3. a sufficient number of Monitoring Points and Background Monitoring Points installed at appropriate locations and depths to yield ground water samples from zones of perched water to provide the data needed to evaluate the effectiveness of the corrective action program.

(2) **Alternate Background Locations** — The ground water monitoring system may include Background Monitoring Points that are not hydraulically upgradient of the Unit if the discharger demonstrates to the satisfaction of the RWQCB that sampling at other Background Monitoring Points will provide samples that are representative of the background quality of ground water or are more representative than those provided by the upgradient Background Monitoring Points.

(3) **Drillers' Logs** — Copies of drillers' logs which the Department of Water Resources requires to be submitted pursuant to section 13751 of the California Water Code shall be submitted to the RWQCB.

(4) **Monitoring Well Performance Standards.**

(A) All monitoring wells shall be cased and constructed in a manner that maintains the integrity of the monitoring well bore hole and prevents the bore hole from acting as a conduit for contaminant transport.

(B) The sampling interval of each monitoring well shall be appropriately screened and fitted with an appropriate filter pack to enable collection of representative ground water samples.

(C) For each monitoring well, the annular space (i.e., the space between the bore hole and well casing) above and below the sampling interval shall be appropriately sealed to prevent entry of contaminants from the ground surface, entry of contaminants from the unsaturated zone, cross contamination between portions of the zone of saturation, and contamination of samples.

(D) All monitoring wells shall be adequately developed to enable collection of representative ground water samples.

(c) **Surface Water Monitoring Systems.**

(1) **General** — The discharger shall establish a surface water monitoring system to monitor each surface water body that could be affected by a release from the Unit.

(2) **Each Monitored Surface Water Body** — Each surface water monitoring system shall include:

(A) **Background Monitoring Points** — a sufficient number of Background Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that represent the quality of surface water that has not been affected by a release from the Unit;

(B) **For DMP** — for a detection monitoring program (under section 20420), a sufficient number of Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that provide the best assurance of the earliest possible detection of a release from the Unit;

(C) **For EMP** — for an evaluation monitoring program (under section 20425), a sufficient number of Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that provide the data to evaluate changes in water quality due to the release from the Unit; and

(D) **For CAP** — for a corrective action program (under section 20430), a sufficient number of Monitoring Points established at appropriate locations and depths to yield samples from each surface water body that provide the data to evaluate compliance with the Water Standard (of section 20390) and to evaluate the effectiveness of the corrective action program.

(d) **Unsaturated Zone Monitoring System.**

(1) Except as otherwise provided in (d)(5), the discharger shall establish an unsaturated zone monitoring system for each Unit.

(2) **The unsaturated zone monitoring system shall include:**

(A) **Background Monitoring Points** — a sufficient number of Background Monitoring Points established at appropriate locations and depths to yield soil pore liquid samples or soil pore liquid measurements that represent the quality of soil pore liquid that has not been affected by a release from the Unit;

(B) **For DMP** — for a detection monitoring program (under section 20420), a sufficient number of Monitoring Points established at appropriate locations and depths to yield soil pore liquid samples or soil pore liquid measurements that provide the best assurance of the earliest possible detection of a release from the Unit;

(C) **For EMP** — for an evaluation monitoring program (under section 20425), a sufficient number of Monitoring Points established at appropriate locations and depths to yield soil pore liquid samples or soil pore liquid measurements that provide the data to evaluate changes in water quality due to the release from the Unit; and

(D) **For CAP** — for a corrective action program (under section 20430), a sufficient number of Monitoring Points established at appropriate locations and depths to yield soil pore liquid samples or soil pore liquid measurements that provide the data to evaluate compliance with the Water Standard (of section 20390) and to evaluate the effectiveness of the corrective action program.

(3) **Background Plot** — Background Monitoring Points shall be installed at a background plot having soil characteristics similar to those of the soil underlying the Unit.

(4) **Alternate Methods** — Liquid recovery types of unsaturated zone monitoring *(e.g., the use of lysimeters)* are required unless the discharger demonstrates to the satisfaction of the RWQCB that such methods of unsaturated zone monitoring cannot provide an indication of a release from the Unit. The RWQCB shall require complementary or alternative (non liquid recovery or remote sensing) types of unsaturated zone monitoring to provide the best assurance of the earliest possible detection of a release from the Unit.

(5) **Exemption** — Unsaturated zone monitoring is required at all new Units unless the discharger demonstrates to the satisfaction of the RWQCB that there is no unsaturated zone monitoring device or method designed to operate under the subsurface conditions existent at that Unit. For a Unit that has operated or has received all permits necessary for construction and operation before 7 1 91, unsaturated zone monitoring is required unless the discharger demonstrates to the satisfaction of the RWQCB that either there is no unsaturated zone monitoring device or method designed to operate under the subsurface conditions existent at that Unit or that installation of unsaturated zone monitoring devices would require unreasonable dismantling or relocating of permanent structures.

(e) **General monitoring requirements.**

(1) All monitoring systems shall be designed and certified by a registered geologist or a registered civil engineer.

(2) **Boring Logs** — All monitoring wells and all other borings (including but not limited to gas monitoring wells) drilled to satisfy the requirements of this division shall be drilled by a licensed drilling contractor (or by a drilling crew under the direct supervision of the design engineer or engineering geologist), and shall be logged during drilling under the direct supervision of a person who is a registered geologist or a registered civil engineer, and who has expertise in stratigraphic well logging. These logs shall be submitted to the RWQCB upon completion of drilling.

(A) Soil shall be described in the geologic log in accordance with current industry-wide practices *[e.g., American Society for Testing and Materials (**ASTM**) Designation "D2488-93 Method for Visual Classification, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)" for field work, with initial determinations backed up by laboratory work under ASTM Designation "D2487-93 Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)," available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959]*.

(B) Rock shall be described in the geologic log in a manner appropriate for the purpose of the investigation.

(C) Where possible, the depth and thickness of saturated zones shall be recorded in the geologic log.

(3) **Shared Systems** — If a facility contains contiguous Units, separate ground water monitoring systems are not required for each such Unit if the discharger demonstrates to the satisfaction of the RWQCB that the water quality monitoring program for each Unit will enable the earliest possible detection and measurement of a release from that Unit.

(4) **QA/QC** — The water quality monitoring program shall include consistent sampling and analytical procedures that are designed to ensure that monitoring results provide a reliable indication of water quality at all Monitoring Points and Background Monitoring Points. At a minimum, the program shall include a detailed description of the procedures and techniques for:

(A) sample collection, including purging techniques, sampling equipment, and decontamination of sampling equipment;

(B) sample preservation and shipment;

(C) analytical procedures; and

(D) chain of custody control.

(5) **Sampling & Analytical Methods** — The water quality monitoring program shall include appropriate sampling and analytical methods for ground water, surface water, and the unsaturated zone that accurately measure the concentration of each COC and the concentration or value of each Monitoring Parameter.

(6) **Initial Background Sampling** — For each Unit, the discharger shall collect all data necessary for selecting the appropriate data analysis methods pursuant to (e)(7-9) and for establishing the background values specified pursuant to (e)(10). At a minimum, this data shall include analytical data obtained during quarterly sampling of all Background Monitoring Points for a period of one year, including the times of expected highest and lowest annual elevations of the ground water surface. For a new Unit, this data shall be collected before wastes are discharged at the Unit and background soil pore liquid data shall be collected from beneath the Unit before the Unit is constructed.

(7) **Propose Data Analysis Method(s)** — Based on data collected pursuant to (e)(6), the discharger shall implement data analysis methods allowed in (e)(8) for each COC and for each Monitoring Parameter. The data analysis methods shall be used in evaluating water quality monitoring data. The specifications for each data analysis method shall include a detailed description of the criteria to be used for determining "measurably significant" (as that term is defined in section 20164) evidence of any release from the Unit and for determining compliance with the Water Standard. Each statistical test specified for a particular COC or Monitoring Parameter shall be conducted for that COC or Monitoring Parameter at each Monitoring Point. Where practical quantitation limits (PQLs) are used in any of the following data analysis methods to comply with (e)(9)(E), the discharger shall identify the PQL to the RWQCB. The discharger shall:

(A) continue using the methods specified in the existing

M&RP; or

(B) submit to the RWQCB, before implementing the selected methods, a comprehensive technical report, certified by an appropriately registered professional, documenting that use of the proposed data analysis methods will comply with the performance standards outlined in (e)(9, 10, & 12):

1. the RWQCB shall audit selected reports submitted pursuant to this subdivision for compliance and applicability, as deemed necessary by the RWQCB; and

2. the discharger shall not change the data analysis methods developed pursuant to this subdivision until the next review/update of the M&RP, unless directed to make changes by the RWQCB; or

(C) use any water quality data analysis software the SWRCB or RWQCB deems appropriate for such use, provided that the manner of such use is consistent with the manner of usage the SWRCB or RWQCB has deemed appropriate (without the need for additional substantiation), for that software, and further provided that the discharger notifies the RWQCB before initiating such use.

(8) **Allowable Data Analysis Methods** — The statistical data analysis requirement in this article do not preclude the use of a particular non-statistical method which can achieve the goal of the particular monitoring program at least as well as will the most appropriate statistical method. If statistical methods cannot meet these goals, the discharger's proposed non-statistical method must achieve the goal of the particular monitoring program adequately [see (e)(12)(A)1.-3.]. For those monitoring data analyses in which statistical methods are used, the discharger shall use one of the following methods:

(A) **Parametric ANOVA** — a parametric analysis of variance (**ANOVA**) followed in all instances by a multiple comparisons procedure to identify "measurably significant" (see section 20164) evidence of a release from the Unit. The method shall include estimation and testing of the contrasts between each monitoring point's mean and the background mean value for each constituent or parameter;

(B) **Nonparametric ANOVA** — an ANOVA based on ranks followed in all instances by a multiple comparisons procedure to identify "measurably significant" (see section 20164) evidence of a release from the Unit. The method shall include estimation and testing of the contrasts between each monitoring point's median and the background median values for each constituent of concern or monitoring parameter;

(C) **Tolerance Interval** — a tolerance or prediction interval procedure in which an interval for each COC or Monitoring Parameter is established from the distribution of the background data, and the value for each COC or Monitoring Parameter at each monitoring point is compared to the upper tolerance or prediction limit;

(D) **Control Chart** — a control chart approach that gives control limits for each COC or Monitoring Parameter; or

(E) **Other Statistical Methods** — any statistical test method submitted by the discharger including, but not limited to, any statistical method which includes a procedure to verify that there is "measurably significant" (see section 20164) evidence of a release from the Unit. If the statistical test method includes a verification procedure, this procedure shall include either a single "composite" retest (i.e., a statistical analysis that augments and reanalyzes the data from the Monitoring Point that indicated a release) or shall consist of at least two "discrete" retests (i.e., statistical analyses each of which analyzes only newly acquired data from the Monitoring Point that indicated a release). The verification procedure shall comply with the following requirements in addition to the statistical performance standards under (e)(9):

1. **Discrete Retest Rule** — if the verification procedure consists of discrete retests, rejection of the null hypothesis for any one of the retests shall be considered confirmation of "measurably significant" (see section 20164) evidence of a release;

2. **Retest Sample Size** — the number of additional samples collected and analyzed for use in the verification procedure shall be appropriate for the form of statistical test specified in the WDRs for that COC or Monitoring Parameter pursuant to (e)(7). The number of additional samples (obtained at the indicating Monitoring Point for the indicating COC or Monitoring Parameter) shall be greater than or equal to the number of samples specified in the WDRs for that constituent or parameter pursuant to (e)(12)(A);

3. **30-Day Resampling Window** — if resampling at the interval identified for use in the initial statistical test pursuant to (e)(12)(B) would cause the entire resampling effort to take longer than 30 days, the sampling interval for use in the verification procedure shall be reduced to ensure that all samples are collected and submitted for laboratory analysis within 30 calendar days from the time that the discharger determines "measurably significant" (see section 20164) evidence of a release pursuant to section 20420(g or i);

4. **Data Mix (for Composite Retest)** — for a verification procedure containing a composite retest, the statistical verification procedure shall be based on all data obtained from the initial sampling event combined with all data obtained during the resampling event. For a verification procedure containing discrete retests, each retest shall analyze data obtained during its respective resampling event(s) and no data shall be shared between retests;

5. **Retest Effects on Type I Error Rate** — the Type I error for statistical methods employing a

retest procedure shall be as follows:

a. **When Initial Test = Retest —** in cases where the discharger proposes to use the same statistical test for both the initial test and the retest, either:

i. **For Composite Retest** — for a verification procedure containing a composite retest, the statistical test method used in the verification procedure shall be conducted at a Type I error rate of no less than 0.05 for both the experiment wise analysis (if any) and the individual Monitoring Point comparisons. Therefore, if a control chart approach is used to evaluate water quality monitoring data, the upper limit on an X Bar or R Chart must be set at no more than 1.645 standard deviations of the statistic plotted for a one sided statistical comparison or at no more than 1.96 standard deviations of the statistic plotted for a two sided statistical comparison; or

ii. **For Discrete Retest (& Original Test Too)** — For a verification procedure containing discrete retests, the statistical test method used shall be the same as the method used in the initial statistical comparison. Notwithstanding any provision of (e)(9), the critical value for the tests shall be chosen so that the Type I error rate for all individual monitoring point comparisons is the same, whether for an initial test or for a retest, and is equal to or greater than either

$$(1-[0.95]^{1/[M*W*S]})^{0.5} * (1/R)^{0.5}$$, or

$$1-(0.99)^{1/S}$$,

whichever is larger, where: **M** = the number of Monitoring Parameters (or COCs, as appropriate) being tested by statistical methods during that Reporting Period; **W** = the total number of Monitoring Points at the Unit (considering all monitored media); **S** = the number of times that suites of monitoring data from the Unit are subjected to initial statistical analysis within a period of six months (i.e., for Monitoring Parameter testing, $S>=1$, but for COC testing, $S=1$); and **R** = the number of discrete retests that are to be conducted at a Monitoring Point for a given COC or Monitoring Parameter whose initial statistical analysis, at that Monitoring Point, has indicated the presence of a release (i.e., $R>= 2$); or

b. **When Retest Differs From Initial Test Method —** in cases where the discharger proposes to use a different statistical test for the composite or discrete retest than that which provided the initial indication of a release *(e.g., parametric Tolerance Limit test facility-wide, following by a parametric Prediction Limit retest for any indicating Monitoring Point)*, the individual Monitoring Point error level requirements of (e)(9)(B) do not apply. Nevertheless, the discharger shall demonstrate that the initial and retest method, in combination, provide:

i. a facility-wide false positive rate of >= 5%, for the indicated COC or Monitoring Parameter; and

ii. a statistical power equivalent to or better than the USEPA Reference Power Curve (see Section 5 and Appendix B of "*Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities C Addendum To Interim Final Guidance*", USEPA Office of Solid Waste, Washington, D.C., July, 1992), which is hereby incorporated by reference.

6. **Reporting** — the discharger shall report to the RWQCB by certified mail the results of both the initial statistical test and the results of the verification procedure, as well as all concentration data collected for use in these tests within seven days of the last laboratory analysis of the samples collected for the verification procedure; and

7. **Scope** — the verification procedure shall only be performed for the constituent(s) or parameters which has shown "measurably significant" (see section 20164) evidence of a release, and shall be performed for those Monitoring Points at which a release is indicated.

(9) **Data Analysis Method Performance Standards** — In cases where the discharger proposes to use a non-statistical data analysis method, the discharger shall demonstrate that it meets the performance standard given in the leading paragraph of (e)(8). Each statistical method chosen under (e)(7) for specification in the WDRs shall comply with the following performance standards for each six month period:

(A) **Fit & Performance** — the statistical method used to evaluate water quality monitoring data shall be appropriate for the distribution of the COC or Monitoring Parameter to which it is applied and shall be the least likely of the appropriate methods to fail to identify a release from the Unit. If the distribution of a COC or Monitoring Parameter is shown by the discharger to be inappropriate for a normal theory test, then the data shall be either transformed so that the distribution of the transformed data is appropriate for a normal theory test or a distribution free theory test shall be used. If the distributions for the COC or Monitoring Parameters differ, more than one statistical method may be needed;

(B) **Level** — if an individual Monitoring Point comparison procedure is used to compare an individual Monitoring Point constituent concentration or Monitoring Parameter value with a concentration limit in the Water Standard or with a background Monitoring Parameter value, the test shall be done at a Type I error rate (as a decimal fraction) no less than 0.01. If a multiple comparisons procedure is used, the Type I experiment wise error rate (experiment-wise) shall be no less than 0.05; however, a Type I error rate of no less than 0.01 for individual Monitoring Point comparisons shall be maintained. This performance standard does not apply to tolerance intervals, prediction intervals, control charts, or any method using discrete retests [for levels applicable to the latter case, see (e)(8)(E)5.b.];

(C) **Control Chart Rate** — if a control chart approach is used to evaluate water quality monitoring data, the specific type of control chart and its associated statistical parameter values *(e.g., the upper control limit)* shall be included in the supporting documentation under (e)(7). The discharger shall use the procedure only if the discharger's supporting documentation under (e)(7) shows the procedure to be protective of human health and the environment. Any control charting procedure must have a false positive rate of no less than 1 percent for each Monitoring Point charted *(e.g., upper control limits on X bar or R Charts used only once every six months must be set at no more than 2.327 standard deviations of the statistic plotted for a one sided statistical comparison or at no more than 2.576 standard deviations of the statistic plotted for a two sided statistical comparison)*;

(D) **Tol. Int./Pred. Int. Rate** — if a tolerance interval or a prediction interval is used to evaluate water quality monitoring data, the levels of confidence and, for tolerance intervals, the percentage of the population that the interval must contain shall be proposed by the discharger and included in the technical documenation submitted to the RWQCB pursuant to (e)(7). The discharger can use the parameters only if the documentation submitted under (e)(7) shows these statistical parameters to be protective of human health and the environment. These statistical parameters shall be determined after considering the number of samples in the background data base, the data distribution, and the range of the concentrations or values for each COC or Monitoring Parameter. The coverage of any tolerance interval used shall be no more than 95 percent and the confidence coefficient shall be no more than 95 percent for a six month period. Prediction intervals shall be constructed with an experiment wise error rate of no less than 5 percent and an individual monitoring point error rate of no less than 1 percent;

(E) **Addressing Censored Data** — the statistical method shall account for data below the practical quantitation limit with one or more statistical procedures that are protective of human health and the environment. Any practical quantitation limit validated pursuant to (e)(7) that is used in the statistical method shall be the lowest concentration (or value) that can be reliably achieved within limits of precision and accuracy specified in the WDRs for routine laboratory operating conditions that are available to the facility. The discharger's technical report, under (e)(7) shall consider the practical quantitation limits listed in Appendix IX to Chapter 14 of Division 4.5 of Title 22, California Code of Regulations (Appendix IX) for guidance when specifying limits of precision and accuracy in the WDRs;

(F) **Seasonal/Spatial Variability** — if necessary, the statistical methods shall include procedures to control or correct for seasonal and spatial variability as well as temporal correlation in the data; and

(G) **Outliers** — any quality control procedure that is declared for use, in the technical report under (e)(7), for application to water quality data from downgradient monitoring points for a monitored medium shall also be applied to all newly acquired background data from that medium. Any newly acquired background monitoring datum that is rejected by an approved quality control procedure shall be maintained in the facility record but shall be excluded from use in statistical comparisons with downgradient water quality data.

(10) **Background Values/Procedures** — Based on the data collected pursuant to (e)(6) and the data analysis methods addressed in the technical report under (e)(7), the discharger shall justify the use of a procedure for determining a background value for each COC and for each Monitoring Parameter specified in the WDRs. These procedures shall be proposed for ground water, surface water, and the unsaturated zone. The discharger shall declare and substantiate one of the following methods in the technical report under (e)(7):

(A) **By Reference to Historical Data** — a procedure for determining a background value for each constituent or parameter that does not display appreciable variation; or

(B) **By Using a Formula/Procedure** — a procedure for establishing and updating a background value for a constituent or parameter to reflect changes in the background water quality if the use of contemporaneous or pooled data provides the greatest power to the data analysis method for that constituent or parameter.

(11) [Reserved]

(12) **Sampling Methods** — For each COC and Monitoring Parameter listed in the WDRs, the discharger shall verify, in the technical report under (e)(7), that the sampling methods to be used to establish background values and the sampling methods to be used for monitoring pursuant to this article are consistent with the following:

(A) **Sample Size** — the number and kinds of samples collected shall be appropriate for the form of data analysis employed and, in the case of statistical data analysis shall follow generally accepted statistical principles. The "**sample size**" (i.e., the number of water quality data points representing a given Monitoring Point or Background Monitoring Point) approved for the data analysis method shall be as large as necessary to ensure with reasonable confidence that:

1. for a detection monitoring program, a release from the Unit will be detected;

2. for an evaluation monitoring program, changes in water quality due to a release from the Unit will be recognized; and

3. for a corrective action program, compliance with the water quality protection standard and effectiveness of the corrective action program will be determined; and

(B) **Data Collection & Analysis** — the sampling method (including the sampling frequency and the interval of time between successive samples) shall be appropriate for the medium from which samples are taken *(e.g., ground water, surface water, and soil pore liquid)*. For ground water, sampling shall be scheduled to include the times of expected highest and lowest elevations of the potentiometric surface. The sampling method shall assure, to the greatest extent possible, that independent samples are obtained. For ground water, the discharger can use a post-sampling purge to assure sample independence whenever the time between successive sampling events (for a given COC or Monitoring Parameter) is insufficient to assure sample independence, in which case the volume of well water to be withdrawn from the well bore for the post sampling purge shall be determined by the same method used to determine adequate pre sampling purging. The sampling method selected shall include collection of at least the appropriate number of new data points [pursuant to (e)(12)(A)] at least semi annually from each Monitoring Point and background monitoring point and data analysis carried out at least semi annually. The RWQCB shall require more frequent sampling and statistical analysis than is stated in the discharger's technical report under (e)(7) where necessary to protect human health or the environment.

(13) **Elevation & Field Parameters** — The ground water portion of the monitoring program shall include an accurate determination of the ground water surface elevation and field parameters (temperature, electrical conductivity, turbidity, and pH) at each well each time ground water is sampled.

(14) **Annual Data Graphs** — The discharger shall graph all analytical data from each Monitoring Point and Background Monitoring Point and shall submit these graphs to the RWQCB at least once annually, except that graphs are not required for constituents for which no new data has been collected since the previous graph submittal. Graphs shall be at a scale appropriate to show trends or variations in water quality. All graphs for a given constituent shall be plotted at the same scale to facilitate visual comparison of monitoring data. Unless the discharger receives written approval from the RWQCB to use an alternate procedure that more effectively illustrates trends or variations in the data, each graph shall represent data from one Monitoring Point or Background Monitoring Point and one Constituent of Concern or Monitoring Parameter.

(15) **G.W. Flow Direction** — In addition to the water quality sampling conducted pursuant to the requirements of this article, the discharger shall measure the water elevation in each well and determine ground water flow rate and direction in the uppermost aquifer and in any zones of perched water and in any additional portions of the zone of saturation monitored pursuant to (b)(1) at least quarterly, including the times of expected highest and lowest elevations of the water levels in the wells.

(16) **Operating Record** — Water quality monitoring data collected in accordance with this article, including actual values of constituents and parameters, shall be maintained in the facility operating record. The RWQCB shall specify in the WDRs when the data shall be submitted for review.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.

20420. SWRCB - Detection Monitoring Program. (C15: Section 2550.8)

(a) **General** — A discharger required, pursuant to section 20385, to establish a detection monitoring program for a Unit shall, at a minimum, comply with the requirements of this section for that Unit.

(b) **Standards** — The discharger subject to this section shall install water quality monitoring systems that are appropriate for detecting, at the earliest possible time, a release from the Unit, and that comply with applicable provisions of section 20415.

(c) **Background** — The discharger shall establish a background value pursuant to section 20415(e)(10) for each Monitoring Parameter specified pursuant to (e) and for each Constituent of Concern under section 20395.

(d) **Water Standard** — The RWQCB shall specify the Water Standard under section 20390 in the WDRs.

(e) **Monitoring Parameters** — The discharger shall propose for approval by the RWQCB a list of Monitoring Parameters for each medium (ground water, surface water, and the unsaturated zone) to be monitored pursuant to (i) and section 20415, including a data analysis method meeting the requirements of that section for each Monitoring Parameter. The list for each monitored medium shall include those physical parameters, hazardous constituents, waste constituents, and reaction products that provide a reliable indication of a release from the Unit to that medium. In addition, for an MSW landfill, the list of monitoring parameters shall meet the requirements of SWRCB Resolution No. 93-62 (which incorporates by reference the federal requirements of 40CFR258.54). The RWQCB shall specify each list of Monitoring Parameters in the WDRs after considering the following factors:

(1) the types, quantities, and concentrations of constituents in wastes managed at the Unit;

(2) the expected or demonstrated correlation between the proposed Monitoring Parameters and the Constituents of Concern specified for the Unit under section 20395;

(3) the mobility, stability, and persistence of waste constituents or their reaction products;

(4) the detectability of physical parameters, waste constituents, and reaction products; and

(5) the background values and the coefficients of variation of proposed Monitoring Parameters in ground water, surface water, and the unsaturated zone.

(f) **Routine Monitoring** — The discharger shall monitor [pursuant to (i)] for the Monitoring Parameters listed in the WDRs pursuant to (e). The RWQCB shall specify the frequencies for collecting samples and for analyzing the resulting data, pursuant to section 20415(e)(12).

(g) **Five-Yearly COC Monitoring** — In addition to monitoring for the Monitoring Parameters specified pursuant to (e), the discharger shall periodically monitor for COCs specified in the WDRs, and shall determine, pursuant to (i), whether there is "measurably significant" (see definition in section 20164) evidence of a release for any COC using the data analysis procedure specified pursuant to section 20415(e)(7). The RWQCB shall specify in WDRs the frequencies and locations for monitoring pursuant to this paragraph after considering the degree of certainty associated with the expected or demonstrated correlation between values for Monitoring Parameters and values for the COCs. Monitoring pursuant to this paragraph shall be conducted at least every five years.

(h) **Data Record & Format —** The discharger shall maintain a record of water quality analytical data as measured and in a form necessary for implementing the data analysis procedure required pursuant to (g) and (i).

(i) **Data Analysis —** For each Monitoring Point, the discharger shall determine whether there is "measurably significant" (see section 20164) evidence of a release from the Unit for any Monitoring Parameter (or COC) specified in the WDRs pursuant to (e) at a frequency specified pursuant to (f) or (g).

> (1) In determining whether "measurably significant" (see section 20164) evidence of a release from the Unit exists, the discharger shall use the method(s) chosen pursuant to section 20415(e)(7). This method(s) shall be used to compare data collected at the Monitoring Point(s) with the background water quality data, except as otherwise provided in section 20400(i).
>
> (2) **Determination —** The discharger shall determine whether there is "measurably significant" (see section 20164) evidence of a release from the Unit at each Monitoring Point within a reasonable period of time after completion of sampling. The RWQCB shall specify in the WDRs what period of time is reasonable after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of samples.
>
> (3) **RWQCB Finding —** The provisions of this section shall not preclude the RWQCB from making an independent finding that there is "measurably significant" (see section 20164) evidence of a release from the Unit. If the RWQCB makes such a finding, the discharger shall comply with the provisions of this section that are required in response to "measurably significant" (see section 20164) evidence of a release from the Unit.

(j) **If Release Indicated —** If the discharger determines pursuant to (i) that there is "measurably significant" (see section 20164) evidence of a release from the Unit, the discharger:

> (1) **Notification —** shall immediately notify RWQCB staff verbally of the finding and shall provide written notification by certified mail within seven days of such determination. The notification shall, for each affected monitoring point, identify the monitoring parameters and constituents of concern that have indicated "measurably significant" (see section 20164) evidence of a release from the Unit;
>
> (2) **Retest Optional —** can immediately initiate the verification procedure pre approved by the RWQCB [pursuant to section 20415(e)(8)(E)] to verify that there is "measurably significant" (see section 20164) evidence of a release from the Unit for a parameter or constituent which has indicated a release at a Monitoring Point; and
>
> (3) **Next Step —** immediately following detection of a release [or after completing the retest under (j)(2)], shall comply with the requirements of (k).

(k) **Responding to Release Discovery —** If a verification procedure, performed pursuant to (j)(2), confirms that there is "measurably significant" (see section 20164) evidence of a release from the Unit or if the discharger does not resample the discharger shall perform the following:

(1) **Non-Statistical COC Scan** — if the detection was made based upon sampling and analysis for Monitoring Parameters [under (f)], immediately sample all Monitoring Points in the affected medium at that Unit and determine the concentration of all COC. Because this COC scan does not involve statistical testing, the discharger need collect and analyze only a single water sample from each Monitoring Point in the affected medium. The RWQCB can approve an appropriate subset of Monitoring Points to be sampled for all COCs, based upon the hydrogeologic conditions at the Unit;

(2-4) [Reserved.];

(5) **Amended ROWD Proposing EMP** — within 90 days of determining "measurably significant" (see section 20164) evidence of a release, submit to the RWQCB an amended report of waste discharge to establish an evaluation monitoring program meeting the provisions of section 20425. The report shall include the following information:

> (A) **COC Concentrations** — the maximum concentration of each COC at each Monitoring Point as determined during the most recent COC sampling event [i.e., under (g) or (k)(1)];
> (B) **Proposed Monitoring System Changes** — any proposed changes to the water quality monitoring systems at the Unit necessary to meet the provisions of section 20425;
>
> (C) **Proposed Monitoring Changes** — any proposed additions or changes to the monitoring frequency, sampling and analytical procedures or methods, or statistical methods used at the Unit necessary to meet the provisions of section 20425; and
>
> (D) **Proposed Delineation Approach** — a detailed description of the measures to be taken by the discharger to assess the nature and extent of the release from the Unit;

(6) **Submit Initial EFS** — within 180 days of determining measurably significant evidence of a release, submit to the RWQCB an engineering feasibility study for a corrective action program necessary to meet the requirements of section 20430. At a minimum, the feasibility study shall contain a detailed description of the corrective action measures that could be taken to achieve background concentrations for all Constituents of Concern; and

(7) **Optional Demonstration (That Unit Is Not At Cause)** — if the discharger determines, pursuant to (i), that there is "**measurably significant**" (see section 20164) evidence of a release from the Unit at any Monitoring Point, the discharger may demonstrate that a source other than the Unit caused the evidence of a release or that the evidence is an artifact caused by an error in sampling, analysis, or statistical evaluation or by natural variation in the ground water, surface water, or the unsaturated zone. The discharger may make a demonstration pursuant to this subsection in addition to or in lieu of submitting both an amended report of waste discharge pursuant to (k)(5) and an engineering feasibility study pursuant to (k)(6); however, the discharger is not relieved of the requirements specified in (k)(5) and (k)(6) unless the demonstration made pursuant to this subsection successfully shows that a source other than the Unit caused the evidence of a release or that the evidence resulted from error in sampling, analysis, or evaluation, or from natural variation in ground water, surface water, or the unsaturated zone. In making a demonstration pursuant to this subsection, the discharger shall:

(A) **Notification of Intent —** within seven days of determining "measurably significant" (see section 20164) evidence of a release, notify the RWQCB by certified mail that the discharger intends to make a demonstration pursuant to this subsection [(k)(7)];

(B) **Demonstration Due Date —** within 90 days of determining "measurably significant" (see section 20164) evidence of a release, submit a report to the RWQCB that demonstrates that a source other than the Unit caused the evidence, or that the evidence resulted from error in sampling, analysis, or evaluation, or from natural variation in ground water, surface water, or the unsaturated zone;

(C) **Amended ROWD —** within 90 days of determining "measurably significant" (see section 20164) evidence of a release, submit to the RWQCB an amended report of waste discharge to make any appropriate changes to the detection monitoring program; and

(D) **DMP Continues —** continue to monitor in accordance with the detection monitoring program established pursuant to this section.

(l) **Changes in Response to Other Problems —** If the discharger determines that there is significant physical evidence of a release, as described in section 20385(a)(3), or that the detection monitoring program does not satisfy the requirements of this section, the discharger shall:

(1) notify the RWQCB by certified mail within 7 days of such determination; and

(2) within 90 days of such determination, submit an amended report of waste discharge to make any appropriate changes to the program.

(m) **Changes By RWQCB —** Any time the RWQCB determines that the detection monitoring program does not satisfy the requirements of this section the RWQCB shall send written notification of such determination to the discharger by certified mail, return receipt requested; the discharger shall, within 90 days after receipt of such notification by the RWQCB, submit an amended report of waste discharge to make any appropriate changes to the program.

(n) [Reserved.]

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.

20425. SWRCB - Evaluation Monitoring Program. (C15: Section 2550.9)

(a)**General —**

(1) A discharger required pursuant to section 20385 to establish an evaluation monitoring program for a Unit shall, at a minimum, comply with the requirements of this section for that Unit.

(2) **Standards —** The evaluation monitoring program shall be used to

assess the nature and extent of the release from the Unit and to design a corrective action program meeting the requirements of section 20430.

(b) **90 Days To Delineate Release** — The discharger shall collect and analyze all data necessary to assess the nature and extent of the release from the Unit. This assessment shall include a determination of the spacial distribution and concentration of each COC throughout the zone affected by the release. The discharger shall complete and submit this assessment within 90 days of establishing an evaluation monitoring program. For MSW landfills, the discharger shall comply with the additional notification and monitoring system requirements incorporated by reference into SWRCB Resolution No. 93-62, regarding notification and monitoring relative to offsite or potential off-site migration of waste constituents [see sections 258.55(g)(1)(ii & iii) of 40CFR258].

(c) **90 Days to Update EFS** — Based on the data collected pursuant to (b) and (e), the discharger shall update the engineering feasibility study for corrective action required pursuant to section 20420(k)(6). The discharger shall submit this updated engineering feasibility study to the RWQCB within 90 days of establishing an evaluation monitoring program.

(d) **90 Days to Amend ROWD** — Based on the data collected pursuant to (b) and on the engineering feasibility study submitted pursuant to (c), the discharger shall submit an amended report of waste discharge to establish a corrective action program meeting the requirements of section 20430. The discharger shall submit this report to the RWQCB within 90 days of establishing an evaluation monitoring program.

(1) **MSW Landfills** — For MSW landfills, the discharger shall meet the additional federal notification requirements incorporated by reference by SWRCB Resolution No. 93-62 [see 40CFR258.56(d)].

(2) **Minimum ROWD Update** — This report shall at a minimum include the following information:

(A) **Delineation of Release** — a detailed assessment of the nature and extent of the release from the Unit;

(B) **Water Standard** — a proposed Water Standard under section 20390, including any proposed CLGBs under section 20400, and all data necessary to justify each such limit;

(C) **Corrective Action Measures** — a detailed description of proposed corrective action measures that will be taken to achieve compliance with the Water Standard proposed for a corrective action program; and

(D) **Monitoring Plan** — a plan for a water quality monitoring program that will demonstrate the effectiveness of the proposed corrective action.

(3) **Coordinated Landfill Gas Control** — For landfills at which the information submitted under (d) indicates that the release likely involves landfill gas, the RWQCB shall notify and shall coordinate, as appropriate, with the EA and (as appropriate) the CIWMB in developing those aspects of the corrective action program involving the design, installation, and operation of the landfill-gas control and monitoring systems at the Unit, such that the resulting gas control program satisfies the needs of all agencies concerned. [Note: the CIWMB's gas control regulations are in Article 6, Subchapter 4, Chapter 3 (section 20920 et seq.)]

(e) **Ongoing Monitoring** — In conjunction with the assessment conducted pursuant to (b), and while awaiting final approval of the amended report of waste discharge, submitted pursuant to (d), the discharger shall monitor ground water, surface water, and the unsaturated zone to evaluate changes in water quality resulting from the release from the Unit. In conducting this monitoring, the discharger shall comply with the following requirements:

(1) **EMP Monitoring Points** — the discharger shall install water quality monitoring systems that are appropriate for evaluation monitoring and that comply with the provisions of section 20415. These water quality monitoring systems can include all or part of existing monitoring systems;

(2) **EMP Monitoring Parameters** — the discharger shall propose for approval by the RWQCB a list of Monitoring Parameters for each medium (ground water, surface water, and the unsaturated zone) to be monitored pursuant to section 20415. The list for each medium shall include all hazardous constituents that have been detected in that medium and those physical parameters, waste constituents, and reaction products that provide a reliable indication of changes in water quality resulting from any release from the Unit to that medium. For MSW landfills, the list of Monitoring Parameters must also meet the federal requirements incorporated by reference into SWRCB Resolution No. 93-62 [see section 258.54(a) and section 258.55(a) of 40CFR258]. The RWQCB shall specify each list of Monitoring Parameters in the WDRs after considering the following factors:

(A) the types, quantities, and concentrations of COCs in wastes managed at the Unit;

(B) information that demonstrates, to the satisfaction of the RWQCB, a sufficient correlation between the proposed Monitoring Parameters and the COCs specified for the Unit;

(C) the mobility, stability, and persistence of COCs [i.e., waste constituents and their (known or anticipated) reaction products];

(D) the detectability of COCs and of monitored physical parameters; and

(E) the background values and the coefficients of variation of proposed Monitoring Parameters in ground water, surface water, and the unsaturated zone;

(3) **Monitoring Parameter Analyses** — the discharger shall monitor for the Monitoring Parameters listed in the WDRs pursuant to (e)(2). The discharger shall use data analysis methods and frequencies for collecting samples and for conducting data analyses that comply with section 20415 (e)(7) for evaluating changes in water quality due to the release from the Unit;

(4) **Five-Yearly COC Monitoring** — in addition to monitoring for the Monitoring Parameters specified pursuant to (e)(3), at least every five years, the discharger shall periodically monitor for all constituents of concern specified in the WDRs to evaluate changes in water quality due to the release from the Unit. The discharger shall use data analysis methods for conducting data anlsyses that comply with section 20415(e)(7) for evaluating changes in water quality due to the release from the Unit;

(5) **Data Records & Format** — the discharger shall conduct water quality monitoring for each Monitoring Parameter and each COC in accordance with section 20415(e)(12). The discharger shall maintain a

record of water quality analytical data as measured and in a form necessary for the evaluation of changes in water quality due to a release from the Unit;

(6) [Reserved.]; and

(7) **Note and Report Changes** — while awaiting final approval of an amended report of waste discharge [submitted under (e)] to establish a corrective action program, the discharger shall evaluate all water quality data obtained pursuant to (e) with respect to the design criteria for the corrective action program. If the evaluation indicates that the plan for corrective action is insufficient, the discharger shall:

(A) notify the RWQCB by certified mail within 7 days of such determination; and

(B) within 90 days of such determination, submit for approval by the RWQCB any appropriate changes to the amended report of waste discharge.

(f) **Optional Demonstration** — The discharger may demonstrate that a source other than the Unit caused the evidence of a release or that the evidence is an artifact caused by an error in sampling, analysis, or statistical evaluation, or by natural variation in ground water, surface water, or the unsaturated zone. Upon a successful demonstration the RWQCB shall specify that the discharger shall reinstitute a detection monitoring program meeting the requirements of §20420. In making a demonstration under this subsection, the discharger shall:

(1) **Notification** — notify the RWQCB by certified mail that the discharger intends to make a demonstration pursuant to this subsection;

(2) **Submit Demonstration Report** — submit a report to the RWQCB that demonstrates that a source other than the Unit caused the evidence of a release or that the evidence resulted from error in sampling, analysis, or evaluation, or from natural variation in ground water, surface water, or the unsaturated zone;

(3) **Submit Amended ROWD** — submit to the RWQCB an amended report of waste discharge to reinstitute a detection monitoring program for the Unit. This report shall propose all appropriate changes to the monitoring program; and

(4) **Continue EMP Monitoring** — continue to monitor in accordance with the evaluation monitoring program established pursuant to this section.

(g) **Interim CAMs** — The RWQCB shall require interim corrective action measures where necessary to protect human health or the environment.

(h) **Discharger-Initiated EMP Changes** — If the discharger determines that the evaluation monitoring program does not satisfy the requirements of this section, the discharger shall, within 90 days, submit an amended report of waste discharge to make any appropriate changes to the program.

(i) **RWQCB-Initiated EMP Changes** — Any time the RWQCB determines that the evaluation monitoring program does not satisfy the requirements of this section, the RWQCB shall send written notification of such determination to the discharger by certified mail, return receipt requested. The discharger shall, within 90 days of such notification by the RWQCB, submit an amended report of waste discharge to make appropriate changes to the program.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, and 13267, Water Code; Section 43103, Public Resources Code.

20430. SWRCB - Corrective Action Program. (C15: Section 2550.10)

(a) **General** — A discharger required pursuant to section 20385 to establish a corrective action program for a Unit shall, at a minimum, comply with the requirements of this section for that Unit.

(b) **Standards** — The discharger shall take corrective action to achieve the following goals: to remediate releases from the Unit; to ensure that the discharger achieves compliance with the Water Standard adopted under section 20390 for that Unit. The RWQCB shall specify the Water Standard for corrective action [including any concentration limits greater than background, under section 20400(c-g)] in the WDRs.

(c) **Scope of Actions** — The discharger shall implement corrective action measures that ensure that COCs achieve their respective concentration limits at all Monitoring Points and throughout the zone affected by the release, including any portions thereof that extend beyond the facility boundary, by removing the waste constituents or treating them in place. The discharger shall take other action approved by the RWQCB to prevent noncompliance with those limits due to a continued or subsequent release from the Unit, including but not limited to, source control. The WDRs shall specify the specific measures that will be taken.

(d) **Monitoring** — In conjunction with the corrective action measures, the discharger shall establish and implement a water quality monitoring program to demonstrate the effectiveness of the corrective action program. Such a monitoring program can be based on the requirements for an evaluation monitoring program (under section 20425), and shall be effective in determining compliance with the Water Standard (under section 20390) and in determining the success of the corrective action measures pursuant to (c).

(e) **Compliance Schedule** — Corrective action measures taken pursuant to this section shall be initiated and completed by the discharger within a period of time specified by the RWQCB in the WDRs.

(f) **Terminating Measures** — Corrective action measures taken pursuant to (c) *(e.g., pumping and treatment of ground water)* may be terminated when the discharger demonstrates to the satisfaction of the RWQCB that the concentrations of all COCs are reduced to levels below their respective concentration limits throughout the entire zone affected by the release.

(g) **Demonstrating Completion of CAP** — After suspending the corrective action measures, pursuant to (f), the Unit shall implement the remaining portions of the Corrective Action Program until an approved Detection Monitoring Program meeting the requirements of section 20420 has been incorporated into WDRs and until the discharger demonstrates to the satisfaction of the RWQCB that the Unit is in compliance with the Water Standard (under section 20390). If the Unit is an MSW landfill, then this demonstration shall meet the federal requirements incorporated by reference in SWRCB Resolution No. 93-62 [see section 258.58(c) of 40CFR258], in lieu of meeting the requirements of (g)(1 & 2). For all other Units, this demonstration shall be based on the following criteria and requirements:

> (1) the concentration of each COC in each sample from each Monitoring Point in the Corrective Action Program for the Unit must have remained at or below its respective concentration limit during a proof period of at least one year, beginning immediately after the suspension of corrective action measures; and

(2) the individual sampling events for each Monitoring Point must have been evenly distributed throughout the proof period and have consisted of no less than eight sampling events per year per Monitoring Point.

(h) **Semi-Annual Progress Reports** — The discharger shall report, in writing, to the RWQCB on the effectiveness of the corrective action program. The discharger shall submit these reports at least semi annually. More frequent reporting shall be required by the RWQCB as necessary to ensure the protection of human health or the environment.

(i) **Discharger-Initiated CAP Changes** — If the discharger determines that the corrective action program does not satisfy the provisions of this section, the discharger shall, within 90 days of making the determination, submit an amended report of waste discharge to make appropriate changes to the program.

(j) **RWQCB-Initiated CAP Changes** — Any time the RWQCB determines that the corrective action program does not satisfy the requirements of this section, the discharger shall, within 90 days of receiving written notification of such determination by the RWQCB, submit an amended report of waste discharge to make appropriate changes to the program.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, 13267 and 13304, Water Code; Section 43103, Public Resources Code.

20435. SWRCB - Unsaturated Zone Monitoring and Response Provisions for Land Treatment Units (LTUs). (C15: Section 2550.11)

(a) **General** — A discharger required pursuant to the provisions of this article to conduct unsaturated zone monitoring at a land treatment unit (**LTU**) shall comply with the unsaturated zone monitoring and response provisions of this section in conjunction with all other unsaturated zone monitoring and response provisions of this article.

(b) **Monitor Below Zone** — The discharger shall monitor the soil and soil pore liquid to determine whether COCs migrate out of the treatment zone.

(c) **Mon. Pars. & COCs** — The RWQCB shall specify the Monitoring Parameters and Constituents of Concern to be monitored in the WDRs. The Monitoring Parameters to be monitored are those specified pursuant to section 20420(e)for detection monitoring and section 20425(e)(2) for evaluation monitoring. The COCs to be monitored are those specified in the Water Standard specified under section 20390 for each monitoring and response program. The COCs to be monitored shall include the constituents, including hazardous constituents, that must be degraded, transformed, or immobilized in the treatment zone of the LTU.

(d) [Reserved.]

(e) **Monitoring Below Treatment Zone** — The discharger shall install an unsaturated zone monitoring system that includes soil monitoring using soil cores and soil pore liquid monitoring using appropriate devices such as lysimeters capable of acquiring soil pore liquid samples. The unsaturated zone monitoring system shall consist of a sufficient number of sampling points at appropriate locations and depths to yield samples that:

(1) represent the quality of background soil pore liquid quality and the chemical makeup of soil that has not been affected by a release from the treatment zone; and

(2) indicate the quality of soil pore liquid and the chemical makeup of the soil below the treatment zone.

(f) **Background** — The discharger shall establish a background value for each monitoring parameter and each COC to be monitored under (c). The discharger shall propose, for approval by the RWQCB, the background values for each Monitoring Parameter and each COC or the procedures to be used to calculate the background values according to the provisions of section 20415(e)(10). The RWQCB shall specify the background values or procedures in WDRs according to section 20415(e)(10).

(g) **Background Plot** — Background soil values may be based on a one time sampling at a background plot having characteristics similar to those of the treatment zone. For new land treatment units, background soil values shall include data from sampling at the proposed plot for the unit.

(h) **Initial Background Data** — Background soil pore liquid values shall be based on at least quarterly sampling for one year at a background plot having characteristics similar to those of the treatment zone. For new land treatment units, background soil pore liquid values shall include data from sampling at the proposed plot for the Unit.

(i) **Data Format** — The discharger shall express all background values in a form necessary for the determination of "measurably significant" (see section 20164) increases pursuant to (n).

(j) **Performance Standard** — In taking samples used in the determination of all background values, the discharger shall use an unsaturated zone monitoring system that complies with (e)(1).

(k) **Timing & Frequency** — The discharger shall conduct soil monitoring and soil pore liquid monitoring immediately below the treatment zone. The RWQCB shall specify the frequency and timing of soil and soil pore liquid monitoring in the WDRs after considering all other monitoring provisions of this article, the frequency, timing, and rate of waste application, the soil hydraulic conductivity, and the maximum anticipated rate of migration. The discharger shall express the results of soil and soil pore liquid monitoring in a form necessary for the determination of "measurably significant" (see section 20164) increases pursuant to (n).

(l) **Propose Procedures** — The discharger shall propose, for approval by the RWQCB, consistent sampling and analysis procedures that are designed to ensure sampling results that provide a reliable indication of soil pore liquid quality and the chemical makeup of the soil below the treatment zone. At a minimum, the discharger shall implement the approved procedures and techniques for:

(1) sample collection;

(2) sample preservation and shipment;

(3) analytical procedures; and

(4) chain of custody control.

(m) **Testing** — The discharger shall determine whether there is a "measurably significant" (see section 20164) increase below the treatment zone using a statistical method that provides reasonable confidence that migration from the treatment zone will be identified. The discharger shall propose each statistical method in accordance with the provisions of this subsection and pursuant to the provisions of section 20415 (e)(7). The RWQCB shall specify each statistical method pursuant to section 20415(e)(7) that the RWQCB finds:

(1) is appropriate for the distribution of the data used to establish background values; and

(2) provides a reasonable balance between the probability of falsely identifying migration from the treatment zone and the probability of failing to identify real migration from the treatment zone.

(n) **Coordinate w/DMP Sampling** — The discharger shall determine whether there is a "measurably significant" (see section 20164) change over background values for each Monitoring Parameter [or, on a five-yearly basis under section 20420(g), for each COC] to be monitored below the treatment zone each time the discharger conducts soil monitoring and soil pore liquid monitoring under (k).

(o) **Data Analysis** — In determining whether a "measurably significant" (see section 20164) increase has occurred, the discharger shall compare the value of each parameter or constituent, using data obtained pursuant to (n), to the background value for that parameter or constituent by using an appropriate statistical procedure specified in the WDRs pursuant to this section.

(p) **Timing of Data Analysis** — The discharger shall determine whether there has been a "measurably significant" (see section 20164) increase below the treatment zone within a reasonable time period after completion of sampling. The RWQCB shall specify this time period in the WDRs after considering the complexity of the statistical test and the availability of laboratory facilities to perform the analysis of soil and soil pore liquid samples.

(q) **Discovery of a Release** — If the discharger determines pursuant to (n), that there has been a "measurably significant" (see section 20164) increase in the value of a hazardous constituent below the treatment zone the discharger shall:

(1) report to the RWQCB describing the full extent of the dischargers findings, including the identification of all constituents that have shown a "measurably significant" (see section 20164) increase, within 72 hours of making such a determination; and

(2) submit written notification of this finding to the RWQCB within seven days of making such a determination.

(r) **Release Response Options** — Upon receiving notice pursuant to (q) or upon the independent confirmation by the RWQCB, the RWQCB shall order the discharger to cease operating the LTU. The discharger shall not resume operating the LTU and shall close the LTU unless one of the following actions is taken:

(1) **Cleanup, and Change Practices** — the discharger completes appropriate removal or remedial actions to the satisfaction of the RWQCB and the discharger submits to the RWQCB and the RWQCB approves, an amended report of waste discharge to modify the operating practices at the unit to maximize the success of degradation, immobilization, or transformation processes in the treatment zone; or

(2) **Cleanup, Line Unit, and Change Practices** — the discharger completes appropriate removal or remedial actions, submits to the RWQCB and the RWQCB approves, an amended report of waste discharge to modify the operating practices at the unit to maximize the success of degradation, immobilization, or transformation processes in the treatment zone, and equips the land treatment unit with liners, and a leachate collection and removal system that satisfy the provisions of section 20330 and section 20340.

(s) **Schedule of Compliance** — All actions taken by a discharger pursuant to (r)(1 or 2) shall be completed within a time period specified by the RWQCB, which shall not exceed 18 months after the RWQCB receives notice pursuant to (q)(1). If the actions are not completed within this time period, the LTU shall be closed, unless granted an extension by the RWQCB due to exceptional circumstances beyond the control of the discharger.

(t) **Optional Demonstration —** If the discharger determines pursuant to (n) that there is a "measurably significant" (see section 20164) increase of hazardous constituents below the treatment zone, the discharger may demonstrate that the increase resulted from an error in sampling, analysis, or evaluation. While the discharger may make a demonstration pursuant to this subsection in addition to or in lieu of the requirements of (r)(1 or 2), the discharger is not relieved of the requirements of (r and s) unless the demonstration made pursuant to this subsection successfully shows that the increase resulted from an error in sampling, analysis, or evaluation. In making a demonstration pursuant to this subsection, the discharger shall:

(1) **Notification —** notify the RWQCB of this finding in writing within seven days of determining a "measurably significant" (see section 20164) increase beneath the treatment zone that the discharger intends to make a demonstration pursuant to this subsection;

(2) **Demonstration Submittal Deadline —** within 90 days of such determination, submit a report to the RWQCB demonstrating that the increase resulted from error in sampling, analysis, or evaluation;

(3) **Amended ROWD Submittal Deadline —** within 90 days of such determination, submit to the RWQCB an amended report of waste discharge to make any appropriate changes to the unsaturated zone monitoring program for the LTU; and

(4) **Continue Monitoring —** continue to monitor in accordance with the unsaturated zone monitoring program established pursuant to this section.

Note:

Authority cited:
Section 1058, Water Code.

Reference:
Sections 13172, 13263, 13267 and 13304, Water Code; Section 43103, Public Resources Code.

Last updated: May 16, 2006

Regulations http://www.ciwmb.ca.gov/Regulations/
Legal Office: dsturges@ciwmb.ca.gov (916) 341-6066
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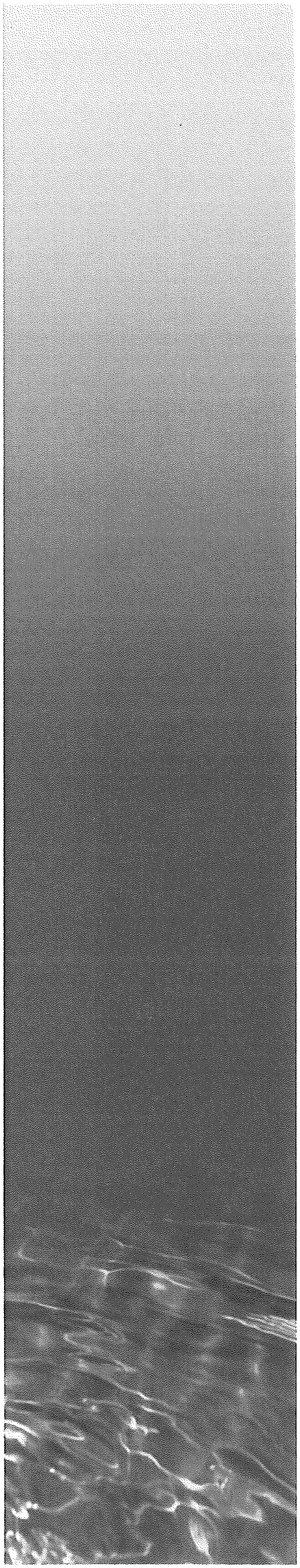

Appendix G

Central Coast Regional Water Quality Control Board Form 200 – Evaporation Ponds

Pajaro River Watershed Groundwater Desalination Feasibility Study

INTRODUCTION

This application package constitutes a Report of Waste Discharge (ROWD) pursuant to California Water Code Section 13260. Section 13260 states that persons discharging or proposing to discharge waste that could affect the quality of the waters of the State, other than into a community sewer system, shall file a ROWD containing information which may be required by the appropriate Regional Water Quality Control Board (RWQCB).

This package is to be used to start the application process for all waste discharge requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES) permits* issued by a RWQCB except:

a) Those landfill facilities that must use a joint Solid Waste Facility Permit Application Form, California Integrated Waste Management Board Form E-1-77; and
b) General WDRs or general NPDES permits that use a Notice of Intent to comply or specify the use of an alternative application form designed for that permit.

This application package contains:

1. Application/General Information Form for WDRs and NPDES Permits [Form 200 (10/97)].
2. Application/General Information Instructions.

Instructions

Instructions are provided to assist you with completion of the application. If you are unable to find the answers to your questions or need assistance with the completion of the application package, please contact your RWQCB representative. *The RWQCBs strongly recommend that you make initial telephone or personal contact with RWQCB regulatory staff to discuss a proposed new discharge before submitting your application.* The RWQCB representative will be able to answer procedural and annual fee related questions that you may have. (See map and telephone numbers inside of application cover.)

All dischargers regulated under WDRs and NPDES permits must pay an annual fee, except dairies, which pay a filing fee only. The RWQCB will notify you of your annual fee based on an evaluation of your proposed discharge. Please do NOT submit a check for your first annual fee or filing fee until requested to do so by a RWQCB representative. Dischargers applying for reissuance (renewal) of an existing NPDES permit or update of an existing WDR will be billed through the annual fee billing system and are therefore requested NOT to submit a check with their application. Checks should be made payable to the State Water Resources Control Board.

Additional Information Requirements

A RWQCB representative will notify you within 30 days of receipt of the application form and any supplemental documents whether your application is complete. If your application is incomplete, the RWQCB representative will send you a detailed list of discharge specific information necessary to complete the application process. The completion date of your application is normally the date when all required information, including the correct fee, is received by the RWQCB.

* **NPDES PERMITS:** If you are applying for a permit to discharge to surface water, you will need an NPDES permit which is issued under both State and Federal law and may be required to complete one or more of the following Federal NPDES permit application forms: Short Form A, Standard Form A, Forms 1, 2B, 2C, 2D, 2E, and 2F. These forms may be obtained at a RWQCB office or can be ordered from the National Center for Environmental Publications and Information at (513) 891-6561.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

INSTRUCTIONS

FOR COMPLETING THE APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR: WASTE DISCHARGE REQUIREMENTS/NPDES PERMIT

If you have any questions on the completion of any part of the application, please contact your RWQCB representative. A map of RWQCB locations, addresses, and telephone numbers is located on the reverse side of the application cover.

I. FACILITY INFORMATION

You must provide the factual information listed below for ALL owners, operators, and locations and, where appropriate, for ALL general partners and lease holders.

A. **FACILITY:**
Legal name, physical address including the county, person to contact, and phone number at the facility. (**NO P.O. Box numbers!** If no address exists, use street and nearest cross street.)

B. **FACILITY OWNER:**
Legal owner, address, person to contact, and phone number. Also include the owner's Federal Tax Identification Number.

OWNER TYPE:
Check the appropriate Owner Type. The legal owner will be named in the WDRs/NPDES permit.

C. **FACILITY OPERATOR (The agency or business, not the person):**
If applicable, the name, address, person to contact, and telephone number for the facility operator. Check the appropriate Operator Type. If identical to B. above, enter "same as owner".

D. **OWNER OF THE LAND:**
Legal owner of the land(s) where the facility is located, address, person to contact, and phone number. Check the appropriate Owner Type. If identical to B. above, enter "same as owner".

E. **ADDRESS WHERE LEGAL NOTICE MAY BE SERVED:**
Address where legal notice may be served, person to contact, and phone number. If identical to B. above, enter "same as owner".

F. **BILLING ADDRESS**
Address where annual fee invoices should be sent, person to contact, and phone number. If identical to B. above, enter "same as owner".

II. TYPE OF DISCHARGE

Check the appropriate box to describe whether the waste will be discharged to: A. Land, or B. Surface Water.

Check the appropriate box(es) which best describe the activities at your facility.

Hazardous Waste - **If you check the Hazardous Waste box, STOP and contact a representative of the RWQCB for further instructions.**

Landfills - **A separate form, APPLICATION FOR SOLID WASTE FACILITY PERMIT/WASTE DISCHARGE REQUIREMENTS, California Integrated Waste Management Board Form E-1-77, may be required. Contact a RWQCB representative to help determine the appropriate form for your discharge.**

III. LOCATION OF THE FACILITY

1. Enter the Assessor's Parcel Number(s) (APN), which is located on the property tax bill. The number can also be obtained from the County Assessor's Office. Indicate the APN for both the facility and the discharge point.

2. Enter the Latitude of the entrance to the proposed/existing facility and of the discharge point. Latitude and longitude information can be obtained from a U.S. Geological Survey quadrangle topographic map. Other maps may also contain this information.

3. Enter the Longitude of the entrance to the proposed/existing facility and of the discharge point.

IV. REASON FOR FILING

NEW DISCHARGE OR FACILITY:
A discharge or facility that is proposed but does not now exist, or that does not yet have WDRs or an NPDES permit.

CHANGE IN DESIGN OR OPERATION:
A material change in design or operation from existing discharge requirements. Final determination of whether the reported change is material will be made by the RWQCB.

CHANGE IN QUANTITY/TYPE OF DISCHARGE:
A material change in characteristics of the waste from existing discharge requirements. Final determination of whether the reported change would have a significant effect will be made by the RWQCB.

CHANGE IN OWNERSHIP/OPERATOR:
Change of legal owner of the facility. Complete Parts I, III, and IV only and contact the RWQCB to determine if additional information is required.

WASTE DISCHARGE REQUIREMENTS UPDATE OR NPDES PERMIT REISSUANCE:
WDRs must be updated periodically to reflect changing technology standards and conditions. A new application is required to reissue an NPDES permit which has expired.

OTHER:
If there is a reason other than the ones listed, please describe the reason on the space provided. (If more space is needed, attach a separate sheet.)

V. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

It should be emphasized that communication with the appropriate RWQCB staff is vital before starting the CEQA documentation, and is recommended before completing this application. There are Basin Plan issues which may complicate the CEQA effort, and RWQCB staff may be able to help in providing the needed information to complete the CEQA documentation.

Name the Lead Agency responsible for completion of CEQA requirements for the project, i.e., completion and certification of CEQA documentation.

Check YES or NO. Has a public agency determined that the proposed project is exempt from CEQA?
If the answer is YES, state the basis for the exemption and the name of the agency supplying the exemption on the space provided. (Remember that, if extra space is needed, use an extra sheet of paper, but be sure to indicate the attached sheet under Section VII. Other.)

Check YES or NO. Has the "Notice of Determination" been filed under CEQA? If YES, give the date the notice was filed and enclose a copy of the Notice of Determination and the Initial Study, Environmental Impact Report, or Negative Declaration. If NO, check the box of the expected type of CEQA document for this project, and include the expected date of completion using the timelines given under CEQA. The date of completion should be taken as the date that the Notice of Determination will be submitted. (If not known, write "Unknown")

VI. OTHER REQUIRED INFORMATION

To be approved, your application MUST include a COMPLETE characterization of the discharge. If the characterization is found to be incomplete, RWQCB staff will contact you and request that additional specific information be submitted.

This application MUST be accompanied by a site map. A USGS 7.5' Quadrangle map or a street map, if more appropriate, is sufficient for most applications.

VII. OTHER

If any of the answers on your application form need further explanation, attach a separate sheet. Please list any attachments with the titles and dates on the space provided.

VIII. CERTIFICATION

Certification by the owner of the facility or the operator of the facility, if the operator is different from the owner, is required. The appropriate person must sign the application form.
Acceptable signatures are:

1. **for a corporation,** a principal executive officer of at least the level of senior vice-president;
2. **for a partnership or individual (sole proprietorship),** a general partner or the proprietor;
3. **for a governmental or public agency,** either a principal executive officer or ranking elected/appointed official.

DISCHARGE SPECIFIC INFORMATION

In most cases, a request to supply additional discharge specific information will be sent to you by a representative of the RWQCB. If the RWQCB determines that additional discharge specific information is not needed to process your application, you will be so notified.

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

STATE WATER RESOURCES CONTROL BOARD
EUREKA
CALIFORNIA

APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

I. FACILITY INFORMATION

A. Facility:

Name:			
Address:			
City:	County:	State:	Zip Code:
Contact Person:		Telephone Number:	

B. Facility Owner:

Name:			Owner Type (Check One) 1. ☐ Individual 2. ☐ Corporation
Address:			3. ☐ Governmental Agency 4. ☐ Partnership
City:	State:	Zip Code:	5. ☐ Other: ________
Contact Person:		Telephone Number:	Federal Tax ID:

C. Facility Operator (The agency or business, not the person):

Name:			Operator Type (Check One) 1. ☐ Individual 2. ☐ Corporation
Address:			3. ☐ Governmental Agency 4. ☐ Partnership
City:	State:	Zip Code:	5. ☐ Other: ________
Contact Person:		Telephone Number:	

D. Owner of the Land:

Name:			Owner Type (Check One) 1. ☐ Individual 2. ☐ Corporation
Address:			3. ☐ Governmental Agency 4. ☐ Partnership
City:	State:	Zip Code:	5. ☐ Other: ________
Contact Person:		Telephone Number:	

E. Address Where Legal Notice May Be Served:

Address:		
City:	State:	Zip Code:
Contact Person:		Telephone Number:

F. Billing Address:

Address:		
City:	State:	Zip Code:
Contact Person:		Telephone Number:

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

STATE WATER RESOURCES CONTROL BOARD
CALIFORNIA

APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

II. TYPE OF DISCHARGE

Check Type of Discharge(s) Described in this Application (A or B):

☐ **A. WASTE DISCHARGE TO LAND** ☐ **B. WASTE DISCHARGE TO SURFACE WATER**

Check all that apply:

☐ Domestic/Municipal Wastewater Treatment and Disposal
☐ Cooling Water
☐ Mining
☐ Waste Pile
☐ Wastewater Reclamation
☐ Other, please describe: ____________________

☐ Animal Waste Solids
☐ Land Treatment Unit
☐ Dredge Material Disposal
☐ Surface Impoundment
☐ Industrial Process Wastewater

☐ Animal or Aquacultural Wastewater
☐ Biosolids/Residual
☐ Hazardous Waste (see instructions)
☐ Landfill (see instructions)
☐ Storm Water

III. LOCATION OF THE FACILITY

Describe the physical location of the facility.

1. Assessor's Parcel Number(s)
Facility:
Discharge Point:

2. Latitude
Facility:
Discharge Point:

3. Longitude
Facility:
Discharge Point:

IV. REASON FOR FILING

☐ New Discharge or Facility
☐ Change in Design or Operation
☐ Change in Quantity/Type of Discharge

☐ Changes in Ownership/Operator (see instructions)
☐ Waste Discharge Requirements Update or NPDES Permit Reissuance
☐ Other: ____________________

V. CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA)

Name of Lead Agency: ____________________

Has a public agency determined that the proposed project is exempt from CEQA? ☐ **Yes** ☐ **No**

If Yes, state the basis for the exemption and the name of the agency supplying the exemption on the line below.

Basis for Exemption/Agency: ____________________

Has a "Notice of Determination" been filed under CEQA? ☐ **Yes** ☐ **No**

If Yes, enclose a copy of the CEQA document, Environmental Impact Report, or Negative Declaration. If no, identify the expected type of CEQA document and expected date of completion.

Expected CEQA Documents:

☐ **EIR** ☐ **Negative Declaration**

Expected CEQA Completion Date: ____________________

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY

State of California
Regional Water Quality Control Board

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CALIFORNIA

APPLICATION/REPORT OF WASTE DISCHARGE GENERAL INFORMATION FORM FOR WASTE DISCHARGE REQUIREMENTS OR NPDES PERMIT

VI. OTHER REQUIRED INFORMATION

Please provide a COMPLETE characterization of your discharge. A complete characterization includes, but is not limited to, design and actual flows, a list of constituents and the discharge concentration of each constituent, a list of other appropriate waste discharge characteristics, a description and schematic drawing of all treatment processes, a description of any Best Management Practices (BMPs) used, and a description of disposal methods.

Also include a site map showing the location of the facility and, if you are submitting this application for an NPDES permit, identify the surface water to which you propose to discharge. Please try to limit your maps to a scale of 1:24,000 (7.5' USGS Quadrangle) or a street map, if more appropriate.

VII. OTHER

Attach additional sheets to explain any responses which need clarification. List attachments with titles and dates below:

You will be notified by a representative of the RWQCB within 30 days of receipt of your application. The notice will state if your application is complete or if there is additional information you must submit to complete your Application/Report of Waste Discharge, pursuant to Division 7, Section 13260 of the California Water Code.

VIII. CERTIFICATION

"I certify under penalty of law that this document, including all attachments and supplemental information, were prepared under my direction and supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Print Name: ______________________ Title: ______________________

Signature: ______________________ Date: ______________________

FOR OFFICE USE ONLY

Date Form 200 Received:	**Letter to Discharger:**	**Fee Amount Received:**	**Check #:**

California Environmental Protection Agency
Bill of Rights for Environmental Permit Applicants

California Environmental Protection Agency (Cal/EPA) recognizes that many complex issues must be addressed when pursuing reforms of environmental permits and that significant challenges remain. We have initiated reforms and intend to continue the effort to make environmental permitting more efficient, less costly, and to ensure that those seeking permits receive timely responses from the boards and departments of the Cal/EPA. To further this goal, Cal/EPA endorses the following precepts that form the basis of a permit applicant's "Bill of Rights."

1. Permit applicants have the right to assistance in understanding regulatory and permit requirements. All Cal/EPA programs maintain an Ombudsman to work directly with applicants. Permit Assistance Centers located throughout California have permit specialists from all the State, regional, and local agencies to identify permit requirements and assist in permit processing.

2. Permit applicants have the right to know the projected fees for review of applications, how any costs will be determined and billed, and procedures for resolving any disputes over fee billings.

3. Permit applicants have the right of access to complete and clearly written guidance documents that explain the regulatory requirements. Agencies must publish a list of all information required in a permit application and of criteria used to determine whether the submitted information is adequate.

4. Permit applicants have the right of timely completeness determinations for their applications. In general, agencies notify the applicant within 30 days of any deficiencies or determine that the application is complete. California Environmental Quality Act (CEQA) and public hearing requests may require additional information.

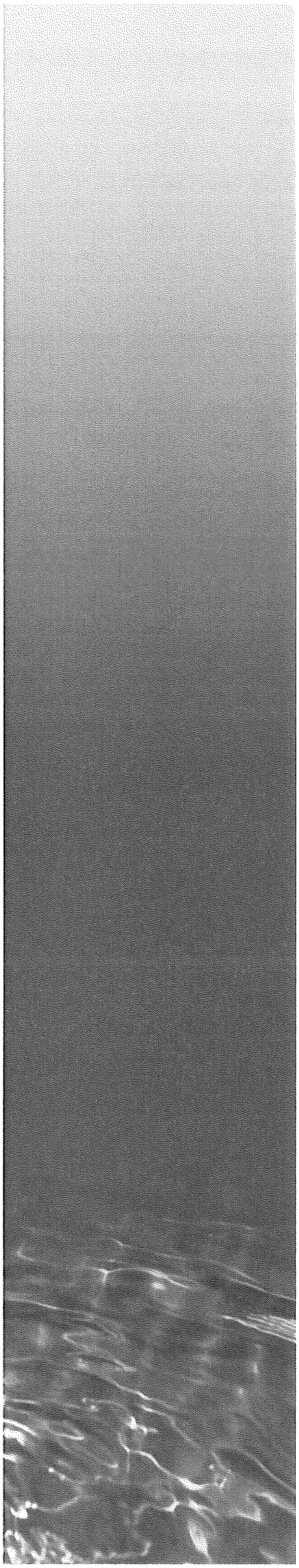
5. Permit applicants have the right to know exactly how their applications are deficient and what further information is needed to make their applications complete. Pursuant to California Government code Section 65944, after an application is accepted as complete, an agency may not request any new or additional information that was not specified in the original application.

6. Permit applicants have the right of a timely decision on their permit application. The agencies are required to establish time limits for permit reviews.

7. Permit applicants have the right to appeal permit review time limits by statute or administratively that have been violated without good cause. For state environmental agencies, appeals are made directly to the Cal/EPA Secretary or to a specific board. For local environmental agencies, appeals are generally made to the local governing board or, under certain circumstances, to Cal/EPA. Through this appeal, applicants may obtain a set date for a decision on their permit and, in some cases, a refund of all application fees (ask boards and departments for details).

8. Permit applicants have the right to work with a single lead agency where multiple environmental approvals are needed. For multiple permits, all agency actions can be consolidated under a lead agency. For site remediation, all applicable laws can be administered through a single agency.

9. Permit applicants have the right to know who will be reviewing their application and the time required to complete the full review process.



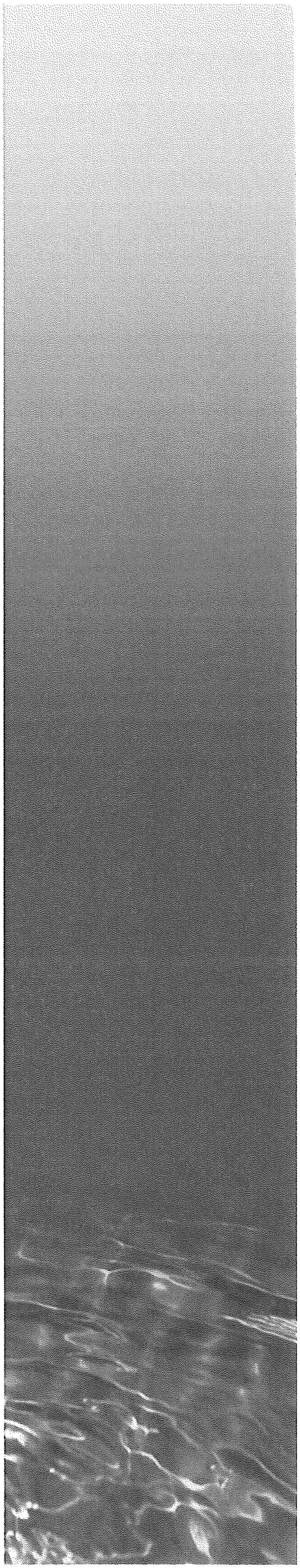
Appendix H

Evaporation Pond Mass Removal Calculations

Pajaro River Watershed Groundwater Desalination Feasibility Study

Salt Removal Calculations

Product Water Flow	1	MGD
Water Recovery	83.0%	
Salt Removal	95.0%	
Brine Flow	0.20	MGD
Groundwater TDS	1,800	mg/L
Influent Salt Load	3,303	tons/year
Product Water TDS	96	mg/L
Product Salt Load	146	tons/year
Brine TDS	10,105	mg/L
Brine Salt Load	3,152	tons/year



Appendix I

Deep Well Injection Feasibility Study Scope

Pajaro River Watershed Groundwater Desalination Feasibility Study

ALL Consulting

Environmental
Oil & Gas
Data Management
Computer / Networks

August 14, 2006

Ryan Alameda
RMC Water and Environment
140 Geary Street., Suite 900
San Francisco, CA 94108

Subject: Proposal to Conduct a Deep Injection Well Feasibility Study

Dear Mr. Alameda:

ALL Consulting (ALL) is pleased to present this proposal and cost estimate for conducting a deep injection well feasibility study for the San Benito County Water District (SBCWD) and RMC. The ALL project team will compile the regional and local data on file with public and private library sources, along with a site specific analysis, to conduct a detailed deepwell feasibility study for the SBCWD Facility.

Scope of Work

This deepwell feasibility study will involve the following work tasks.

- Geologic review of area: This task will involve gathering oil well logs and map data from the California Department of Oil and Gas and other private sources and preparing a stratigraphic view of the subsurface formations in the study area. Regional publications describing potential injection zones will also be located, if available, to assist in the determination of injection capability. Information that will be researched and studied includes:
    - Depth and injection capacity of potential injection zones,
    - Depth and adequacy of confining formations,
    - Depth of the base of the lowest underground source of drinking water,
    - Potential abnormally pressured zones that may be drilled through during the well installation process.
- Regulatory Review: This task involves a review of the applicable State and Federal regulations related to the permitting and installation of injection wells. An analysis of the permitting possibilities for Class I well will be conducted and a list of all the required permits will be prepared. Discussions will be held with State Regulatory personnel to obtain estimated permit review and approval time tables. Possible permitting roadblocks will be discussed with the permitting agency.

- Injection Process Review: This task involves discussions with SBCWD Facility personnel and RMC to determine rates and volumes for injection and preparation of an overview of the proposed injection facilities and wells.
- Cost Estimate Preparation: From the information gained during preparation of the feasibility study, a cost estimate for preparing a Class I disposal well application will be prepared along with a budgetary estimate for installation of the proposed well(s) using prior work conducted by ALL. Estimates for the well installation will be AFE type numbers and is not designed to be an installation quote from ALL.
- Project Schedule: A project schedule for permit preparation and submittal to the regulatory agency will be prepared. The schedule will be prepared using estimates from regulators and ALL knowledge from conducting previous projects similar to this project.

The ALL project team will identify any project issues that could eliminate deep injection as a method of wastewater disposal. Assuming no problems are identified, all the information collected during the feasibility study will be utilized in the preparation of a Class I Non-Hazardous Injection Well Permit Application for one or more injection wells.

Project Team

The ALL project team will consist of engineers and geologists with experience in the preparation of Class I permit applications, injection well design and installation. The work will be managed from our Houston office by Greg Casey. The key members of the project team are listed below.

- Greg Casey, P.E. – Project Manager/Senior Engineer: Mr. Casey has over 21 years of deepwell experience preparing permit applications and modifications, conducting well drilling and completion activities, and conducting well maintenance. He has managed more than 42 deepwell projects including the permitting of 16 new injection wells over the last four years. He has permitted Class I wells in Texas, Oklahoma, Louisiana, California, and Indiana.
- Dan Arthur, P.E. – Senior Engineer: Mr. Arthur has over 21 years experience in the injection well field. His experience includes injection well design, permitting, testing, regulatory review, and project management. He is a former EPA UIC Program Manager from EPA Region V and has worked as a consultant on wells in the central U.S. as well as in Florida.
- Bruce G. Langhus, Ph.D., C.P.G. – Senior Geologist: Dr. Langhus has over 36 years work experience in hydrocarbon exploration, deep well injection, oil and gas regulation, and environmental remediation. He has supervised the drilling of hundreds of wells in the US and Canada. He has interpreted the engineering, seismic, and geological data from thousands of wells in North and South America. Dr. Langhus has prepared detailed geologic studies and permit application information for 18 Class I injection wells during the past 5 years.

- Mark Layne, Ph.D., P.E. – Dr. Layne has a Ph.D in petroleum engineering and is very experience in the modeling of fluid flow below ground surface. He has been working in the injection well field for over 10 years and has experience in well design, installation, modeling and pressure transient testing. He has conducted the reservoir modeling for 10 Class I permits over the past 5 years and prepared a number of annual pressure fall-off testing analysis for Class I clients of ALL.

Summary

ALL has conducted a number of deepwell feasibility studies over the past few years and is very well qualified to conduct this work. We will conduct a deep injection well feasibility study for the SBCWD Facility for $18,500.00. The work will be conducted on a lump sum basis. This cost is based on the assumption that RMC and SBCWD will provide all the pertinent facility information on hand to assist ALL in the preparation of the study. ALL understands the desire to conduct the work as soon as possible and is available to start immediately. Once approved to start, ALL can complete the study in approximately two weeks.

I have attached a copy of ALL's Standard Agreement for Professional Services for this proposed work. If you wish to conduct this work, please sign the document and fax back to me. We look forward to working with you on this project. If you have any questions concerning this proposal or cost estimate, please call me at (281) 290-8907.

Sincerely,

ALL Consulting

B. Greg Casey, P.E.
Principal Member/Senior Engineer

ALL Consulting

STANDARD AGREEMENT FOR PROFESSIONAL SERVICES

ALL's Office Address: 1305 E. 15th Street, Suite 205, Tulsa, Oklahoma 74120

Project Name: Injection Well Feasibility Study ALL Project: No.: NA

Client: RMC Water and Environment

Address: 140 Geary Street San Francisco, CA94108

CLIENT requests and authorizes ALL to perform the following services:

Scope:

Per proposal submitted to Mr. Ryan Alameda (August 14, 2006)

Compensation by CLIENT to ALL will be on the basis of:

Eighteen Thousand Five Hundred Dollars ($18,500) - Lump Sum

Other Terms:

As specified in August 14, 2006 scope of work and assumptions (Proposal to Conduct a Deep Injection Well Feasibility Study).

Services covered by this AGREEMENT will be performed in accordance with the Provisions and any attachments or schedules. This AGREEMENT supersedes all prior agreements and understandings and may only be changed by written amendment executed by both parties.

CLIENT:		ALL Consulting:	
Signature		Signature	
Name (printed)		Name (printed)	B. Greg Casey, P.E.
Title		Title	Principal Member
Date		Date	August 14, 2006

PROVISIONS

1. **Authorization to Proceed**

Execution of this AGREEMENT by CLIENT will be authorization for ALL to proceed with the services, unless otherwise provided for in this AGREEMENT.

2. **Salary Costs**

ALL's Salary Costs, when the basis of compensation, are the amount of wages or salaries paid ALL employees for work directly performed on the Project plus a percentage applied to all such wages or salaries to cover all payroll-related taxes, payments, premiums, and benefits.

3. **Per Diem Rates**

ALL's Per Diem Rates, when the basis of compensation, are those hourly or daily rates charged for work performed on the Project by ALL employees of the indicated classifications. These rates are subject to annual calendar year adjustments.

4. **Affiliated Companies**

Work performed under this AGREEMENT may be performed using labor from affiliated companies of CONSULTANT. Such labor will be billed to OWNER under the same billing terms applicable to CONSULTANT's employees.

5. **Subcontracts and Direct Expenses**

When SERVICES are performed on a cost reimbursement basis, a markup of 15 percent will be applied to subcontracts and outside services and a markup of 10 percent will be applied to Direct Expenses. For purposes of this AGREEMENT, Direct Expenses are defined to include those necessary costs and charges incurred for the Project including, but not limited to: (1) the direct costs of transportation, meals, lodging, mail, shipping, equipment and supplies; (2) ALL's current standard rate charges for direct use of ALL's vehicles, laboratory test and analysis, printing and reproduction services, and field equipment; and (3) ALL's standard project charges for computing systems ($1.50/hour), special health and safety requirements of OSHA (project specific), and telecommunications services ($1.50/hour).

All sales, use, value added, business transfer, gross receipts, or other similar taxes will be added to ALL's compensation when invoicing CLIENT.

6. **Cost Opinions**

Any cost opinions or Project economic evaluations provided by ALL will be on a basis of experience and judgment, but, since ALL has no control over market conditions or bidding procedures, ALL cannot warrant that bids, ultimate construction cost, or Project economics will not vary from these opinions.

7. **Standard of Care**

The standard of care applicable to ALL's services will be the degree of skill and diligence normally employed by professional engineers or consultants performing the same or similar services at the time ALL's services are performed. ALL will re-perform any services not meeting this standard without additional compensation.

8. **Termination**

This AGREEMENT may be terminated for convenience on 30 days' written notice or if either party fails substantially to perform through no fault of the other and does not commence correction of such nonperformance within 5 days of written notice and diligently complete the correction thereafter. On termination, ALL will be paid for all authorized work performed up to the termination date plus termination expenses, such as, but not limited to, reassignment of personnel, subcontract termination costs, and related closeout costs.

9. **Payment to ALL**

Monthly invoices will be issued by ALL for all Services performed under this AGREEMENT. CLIENT shall pay each invoice within 10 days. Interest at a rate of 2 percent per month will be charged on all past-due amounts. Invoicing more frequently than monthly may be used on projects where monthly invoicing amounts may exceed $5,000 per month.

In the event of a disputed billing, only that disputed portion will be withheld from payment, and the undisputed portion will be paid. CLIENT will exercise reasonableness in disputing any bill or portion thereof. No interest will accrue on any disputed portion of the billing until mutually resolved.

10. **Limitation of Liability**

ALL's liability for CLIENT's damages will, in the aggregate, not exceed $10,000. This Provision takes precedence over any conflicting Provision of this AGREEMENT or any document incorporated into it or referenced by it.

This limitation of liability will apply whether ALL's liability arises under breach of contract or warranty; tort, including negligence; strict liability; statutory liability; or any other cause of action, and shall include ALL's officers, affiliated corporations, employees, and subcontractors.

11. **Severability and Survival**

If any of the provisions contained in this AGREEMENT are held illegal, invalid or unenforceable, the other provisions shall remain in full effect. Limitations of liability shall survive termination of this AGREEMENT for any cause.

12. **No Third Party Beneficiaries**

This AGREEMENT gives no rights or benefits to anyone other than CLIENT and ALL and has no third party beneficiaries except as provided in paragraph 10.

13. **Materials and Samples**

Any items, substances, materials, or samples removed from the Project site for testing, analysis, or other evaluation will be returned to the Project site unless agreed to otherwise. CLIENT recognizes and agrees that ALL is acting as a bailee and at no time assumes title to said items, substances, materials, or samples. CLIENT recognizes that ALL assumes no risk and/or liability for a waste or hazardous waste site originated by other than ALL.

14. **Assignments**

Neither party shall have the power to or will assign any of the duties or rights or any claim arising out of or related to this AGREEMENT, whether arising in tort, contract or otherwise, without the written consent of the other party. Any unauthorized assignment is void and unenforceable.

15. **Integration**

This AGREEMENT incorporates all previous communications and negotiations and constitutes the entire agreement of the parties. If CLIENT issues a Purchase Order in conjunction with performance of the Services, general or standard terms and conditions on the Purchase Order do not apply to this AGREEMENT.

16. **Force Majeure**

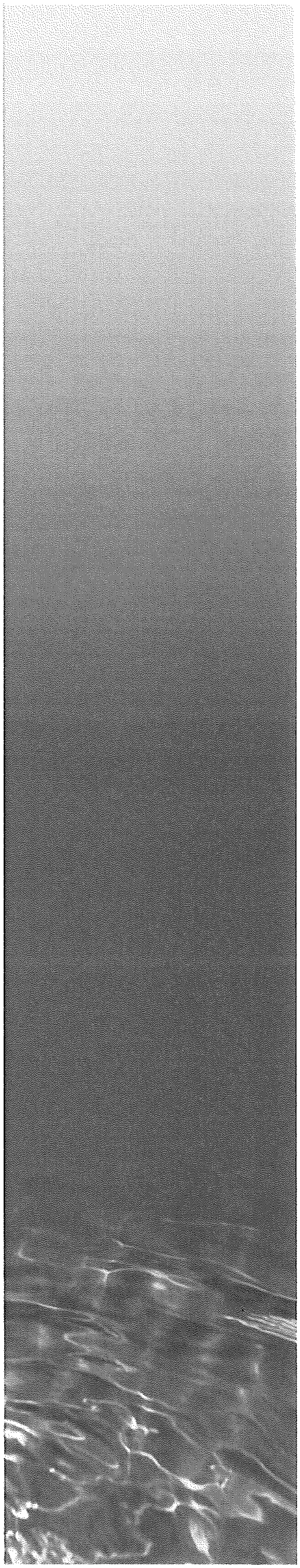
If performance of the Services is affected by causes beyond ALL's reasonable control, project schedule and compensation shall be equitably adjusted.

17. **Dispute Resolution**

The parties will use their best efforts to resolve amicably any dispute, including use of alternative dispute resolution options.

18. **Changes**

Client may make or approve changes within the general Scope of Services in this AGREEMENT. If such changes affect ALL's cost of or time required for performance of the services, an equitable adjustment will be made through an amendment to this AGREEMENT.



Appendix J

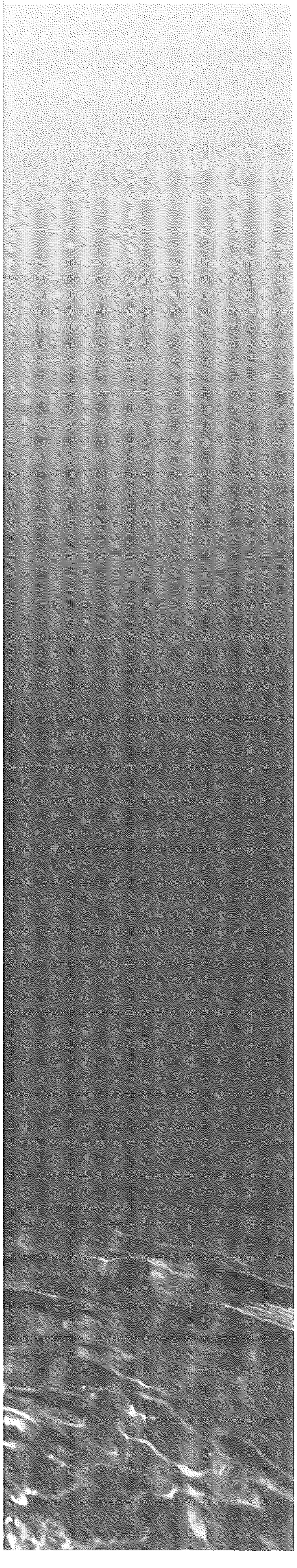
City of Watsonville Wastewater Treatment Plant Discharge Permit Summary

Pajaro River Watershed Groundwater Desalination Feasibility Study

	Constituent	Units	Monthly (30-Day) Average	Weekly (7-day) Average	Daily Maximum
Effluent Limitations for Major Constituents and Properties of Wastewater	BOD5	mg/L	30	45	90
		lb/Day	3,000	4,500	9,000
	CBOD5	mg/L	25	40	75
		lb/Day	2,500	4,000	7,500
	TSS	mg/L	30	45	90
		lb/Day	3,000	4,500	9,000
	Oil and Grease	mg/L	25	40	75
		lb/Day	2,500	4,000	7,500
	Settleable Solids	mL/L	1.0	1.5	3.0
	Turbidity	NTU	75	100	225
	pH	pH Units	Between 6.0 and 9.0 at all times		
	Total Coliforms	#/100 mL	NA	NA	85,000
	Fecal Coliforms	#/100 mL	NA	NA	17,000
	Enterococcus	#/100 mL	NA	NA	2,000
Effluent Limitations for the Protection of Mrine Aquatic Life	Arsenic	ug/L	430	2,500	6,500
		lb/Day	42	250	650
	Cadmium	ug/L	85	340	850
		lb/Day	8.5	34	85
	Chromium (Hexavalent)	ug/L	170	680	1,700
		lb/Day	17	68	170
	Copper	ug/L	87	850	2,400
		lb/Day	8.7	85	240
	Lead	ug/L	170	680	1,700
		lb/Day	17	68	170
	Mercury	ug/L	3.4	14	34
		lb/Day	0.34	1.40	3.40
	Nickel	ug/L	420	1,700	4,200
		lb/Day	42	170	420
	Selenium	ug/L	1,300	5,100	13,000
		lb/Day	130	510	1,300
	Silver	ug/L	46	220	580
		lb/Day	4.6	22	58
	Zinc	ug/L	1,000	6,100	16,000
		lb/Day	100	610	1,600
	Cyanide	ug/L	85	340	850
		lb/Day	8.5	34	85
	Total Chlorine Residual	ug/L	170	680	5,100
		lb/Day	17	68	510
	Ammonia (expressed as N)	ug/L	51,000	200,000	510,000
		lb/Day	5,100	20,000	51,000
	Acute Toxicity	TUa	------	2.8	------
	Chronic Toxicity	TUc	------	85	------
	Phenolic Compounds (nonchlorinated)	ug/L	2,600	10,000	26,000
		lb/Day	260	1,000	2,600
	Chlorinated Phenolics	ug/L	85	340	850
		lb/Day	8.5	34	85
	Endosulfan	ug/L	0.76	1.5	2.3
		lb/Day	0.076	0.15	0.23
	Endrin	ug/L	0.17	0.34	0.51
		lb/Day	0.017	0.034	0.051
	HCH	ug/L	0.34	0.68	1.0
		lb/Day	0.034	0.068	0.1
	Radioactivity	Not to exceed limits specified in Title 17, Division 1, Chapter 5, Subchapter 4, Group 3, Article 3, Section 30251 of the California Code of Regulations.			

Effluent Limitations for the Protection of Human Health - Non-Carcinogens	Acrolein	ug/L	1.9E+04		
		lb/Day	1.9E+04		
	Antimony	ug/L	1.0E+05		
		lb/Day	1.0E+04		
	Bis(2-chloroethoxy) methane	ug/L	370		
		lb/Day	37		
	Bis(2-chloroisopropyl) ether	ug/L	1.0E+05		
		lb/Day	1.0E+04		
	Chlorobenzene	ug/L	4.8E+04		
		lb/Day	4.8E+03		
	Chromium (III)	ug/L	1.6E+07		
		lb/Day	1.6E+06		
	di-n-butyl phthlate	ug/L	3.0E+05		
		lb/Day	3.0E+04		
	Dichlorobenzenes	ug/L	4.3E+06		
		lb/Day	4.3E+04		
	Diethyl phthlate	ug/L	2.8E+06		
		lb/Day	2.8E+05		
	Dimethyl phthlate	ug/L	7.0E+07		
		lb/Day	7.0E+06		
	4,6-dinitro-2-methylphenol	ug/L	1.9E+04		
		lb/Day	1.9E+03		
	2,4-dinitrophenol	ug/L	340		
		lb/Day	34		
	Ethylbenzene	ug/L	3.5E+05		
		lb/Day	3.5E+04		
	Flouranthene	ug/L	1.3E+03		
		lb/Day	130		
	Hexachlorocyclopentadiene	ug/L	4.9E+03		
		lb/Day	490		
	Nitrobenzene	ug/L	420		
		lb/Day	42		
	Thallium	ug/L	170		
		lb/Day	17		
	Toluene	ug/L	7.2E+06		
		lb/Day	7.2E+05		
	Tributyltin	ug/L	0.12		
		lb/Day	0.012		
	1,1,1-trichloroethane	ug/L	4.6E+07		
		lb/Day	4.6E+06		
	Acrylonitrile	ug/L	8.5		
		lb/Day	0.85		
	Aldrin	ug/L	1.9E-03		
		lb/Day	1.9E-04		
	Benzene	ug/L	500		
		lb/Day	50		
	Benzidine	ug/L	5.9E-03		
		lb/Day	5.9E-04		
	Beryllium	ug/L	2.8		
		lb/Day	0.28		
	Bis(2-chloroethyl) ether	ug/L	3.8		
		lb/Day	0.38		
	Bis(2-ethylhexyl) phthlate	ug/L	300		
		lb/Day	30		
	Carbon Tetrachloride	ug/L	85		
		lb/Day	8.5		
	Chlordane	ug/L	2.0E-03		
		lb/Day	2.0E-04		
	Chlorodibromomethane	ug/L	730		
		lb/Day	73		

Effluent Limitations for the Protection of Human Health - Carcinogens	Chloroform	ug/L	1.1E+04		
		lb/Day	1.1E+03		
	DDT	ug/L	0.014		
		lb/Day	1.4.E-03		
	1,4-dichlorobenzene	ug/L	1.5E+03		
		lb/Day	150		
	3,3-dichlorobenzidine	ug/L	0.7		
		lb/Day	0.07		
	1,2-dichloroethane	ug/L	2.4E+03		
		lb/Day	240		
	1,1-dichloroethylene	ug/L	76		
		lb/Day	7.7		
	Dichlorobromomethane	ug/L	530		
		lb/Day	53		
	Dichloromethane	ug/L	3.8E+04		
		lb/Day	3.8E+03		
	1,3-dichloropropene	ug/L	760		
		lb/Day	76		
	Dieldrin	ug/L	3.4E-03		
		lb/Day	3.4E-04		
	2,4-dinitrotoluene	ug/L	220		
		lb/Day	22		
	1,2-diphenylhydrazine	ug/L	14		
		lb/Day	1.4		
	Halomethanes	ug/L	1.1E+04		
		lb/Day	1.1E+03		
	Heptachlor	ug/L	4.2E-03		
		lb/Day	4.2E-04		
	Heptachlor epoxide	ug/L	1.7E-03		
		lb/Day	1.7E-04		
	Hexachlorobenzene	ug/L	0.018		
		lb/Day	1.8E-03		
	Hexachlorobutadiene	ug/L	1.2E+03		
		lb/Day	120		
	Hexachloroethane	ug/L	210		
		lb/Day	21		
	Isophorone	ug/L	6.2E+04		
		lb/Day	6.2E+03		
	N-nitrodimethylamine	ug/L	620		
		lb/Day	62		
	N-nitrosodi-N-propylamine	ug/L	32		
		lb/Day	3.2		
	N-nitrosodiphenylamine	ug/L	210		
		lb/Day	21		
	PAHs	ug/L	0.75		
		lb/Day	0.075		
	PCBs	ug/L	1.6E-03		
		lb/Day	1.6E-04		
	TCDD equivalents	ug/L	3.3E-07		
		lb/Day	3.3E-08		
	1,1,2,2-tetrachloroethane	ug/L	200		
		lb/Day	20		
	Tetrachloroethylene	ug/L	170		
		lb/Day	17		
	Toxaphene	ug/L	0.018		
		lb/Day	1.8E-03		
	Trichloroethylene	ug/L	2.3E+03		
		lb/Day	230		
	1,1,2-trichloroethane	ug/L	800		
		lb/Day	80		
	2,4,6-trichlorophenol	ug/L	25		
		lb/Day	2.5		
	Vinyl chloride	ug/L	3.1E+03		
		lb/Day	310		



Appendix K

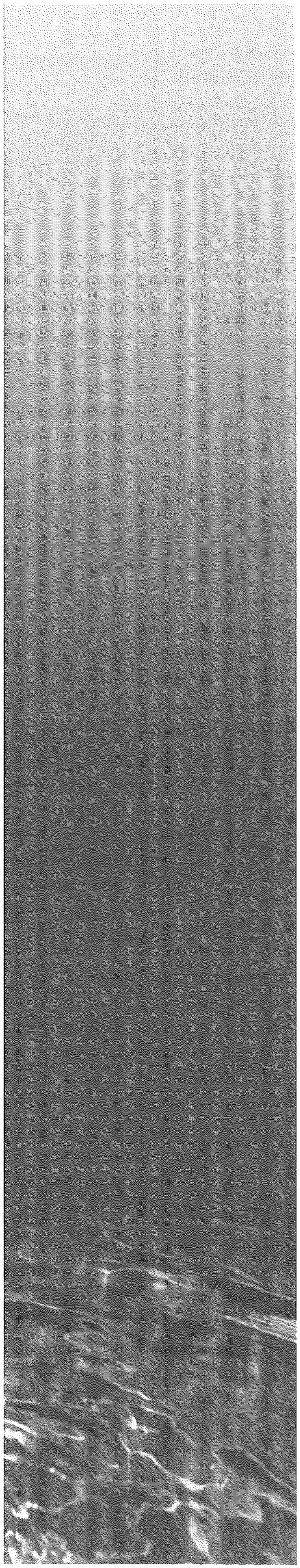
Brine Trucking Cost Estimate

Pajaro River Watershed Groundwater Desalination Feasibility Study

Brine Export Via Trucking Cost Estimate

Treatment Capacity (avg)	1.00	MGD
Waste Brine (avg)	0.205	MGD
Truck Volume	10,000	gal
Trips Per Day	21	trips
Miles Per Trip (one way)	30	miles
Brine Transfer Pump	350	gpm
Loading Time	29	min
Travel Time (one way)	60	min
Unloading Time	29	min
Total Trip Time	3.0	hours
Hours Per Truck Per Day	9	hours
Trips Per Day Per Truck	3.0	Trips/dy/truck
Truck maintenance interval	15,000	miles
Maintenance hours per effort	16	man-hours
Truck fuel use	6	miles per gallon
Gas Price	4	$/gallon
Driver Cost	$ 80,000	$/year incl benefits
Disposal Cost	$ 0.05	$/gallon
Maintenance Labor Cost	$ 75.00	$/hr
Parts per mainteance trip	$ 2,000	$/trip
Maintenance Cost Per Trip	$ 12.80	labor plus parts
Annual Insurance Cost	$ 10,000	
Truck Lease	$ 1,000	$/day

Costs Per Trip		
Truck Lease	$	328.04
Gas	$	40.00
Labor	$	102.56
Disposal	$	500.00
Insurance	$	12.82
Maintenance	$	12.80
TOTAL	**$**	**1,000.00**



Appendix L

LLNL Brine Assessment Report

Pajaro River Watershed Groundwater Desalination Feasibility Study

Report on Task 5.3 of the Pajaro River Watershed Groundwater Desalination Feasibility Study

Prepared for RMC Water and Environment

By

Dr. Elizabeth Burton
Dr. William Bourcier
Dr. Carol Bruton

Lawrence Livermore National Laboratory
7000 East Ave
Livermore, CA 94551

08/31/07

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1. Executive Summary

Lawrence Livermore National Laboratory (LLNL) was subcontracted by RMC Water and Environment (RMC) to conduct Task 5.3 of the Pajaro Watershed Desalination Feasibility Study within a larger study funded by the California Department of Water Resources through Proposition 50.

Task 5.3 consists of two parts. The first part is a desktop modeling study of the potential for selective precipitation of salts from the waste brine to assist in removal of salts from the Pajaro River Watershed. This evaluation is based on anticipated brine chemical characteristics and performed using commercial and LLNL-proprietary computer software. The second part is a bench-top laboratory study of the capabilities of LLNL's proprietary selective membranes or commercial membranes to selectively concentrate constituents of interest and to assess improvements in energy and efficiency.

A groundwater sample was obtained and analyzed for this study. An analysis of source water provided by RMC formed the basis for the modeling analysis. An actual sample of well water supplied by RMC was used by LLNL for the bench-scale laboratory tests.

One key finding of this study was the high tendency of this sample to precipitate scale, even at concentrations lower than the 83% target recovery value, and to cause biofouling in the bench-scale experiments. Although the fluid flow rates in our laboratory system were low (0.5-1 L/m), we have no reason to believe the observed fouling and scaling issues will not also be possible in full scale systems. We suggest that blending of this water with other source waters in the basin should be examined to identify blending ratios that will reduce these problems and their potential costs for any desalination operations.

With respect to the three main objectives of Task 5.3, we have made the following findings:

- Extraction of marketable mineral byproducts that can contribute revenue and reduce solid waste salt residual volumes:
    - The minerals that precipitate from this brine sample do not have economic value.
- Extraction of any hazardous constituents that may otherwise be present in solid waste salt residuals:
    - The precipitates from this brine sample concentrate some hazardous elements, relative to their concentrations in the brine. This may create a hazardous solid waste problem and should be carefully investigated in any pilot studies. Uranium, copper and potentially arsenic, may be health,

safety and environmental concerns. The tendency for these elements to partition into the solid scales, however, may also create some advantages by lowering hazardous element concentrations in order to allow reject brine to meet regulatory limits for low-cost disposal options. We recommend further investigations of these scenarios in pilot-scale studies.

- Increase in product water recovery through selective removal of scale-forming ions that limit recovery:
    - There is no energy efficiency or recovery efficiency advantage in using the membranes tested given the salinity and composition of the sample brine at 83%.
    - The tested membranes showed significant selective removal of divalent anions, and some separation of divalent from monovalent cations. However, given the chemical composition of the brine and the compositions of the scaling minerals that precipitate, there is no particular advantage to using commercial or proprietary membranes to reduce scaling or separate marketable byproducts. However, should blending of this water with other waters within the Pajaro basin result in sulfate mineral scaling, such an approach may have value.
    - Control of carbonate scaling may be accomplished via pH adjustment of fluids during RO operations, however, these adjustments may exacerbate formation of silicate phases.
- From available information on water quality in the Pajaro River watershed, it appears that there is significant groundwater variability. Options to blend source waters of various compositions should be modeled and studied as a possible method for controlling scaling and improving recovery.

2. Source Water and Concentrate Compositions

Source water compositional data provided to LLNL by RMC were based on analyses by Bolsa Analytical's laboratory on Sample #63367, taken from SBCWD Well H5-A. The sample was collected on December 26, 2006 at 15:15. Table 2-1 shows the reported analysis and Figures 2-1 and 2-2 depict its composition graphically.

Based on discussions between RMC and LLNL and review of the water quality data provided to LLNL (Van Horne, et al., 2006), there appears to be substantial variation in the composition of potential source waters being considered for desalination operations.. This compositional range might be taken advantage of by strategic mixing of waters to produce a blended input steam that has more favorable properties for treatment. For example, it may be possible to remove salt through precipitation by mixing appropriate fluids prior to membrane treatment and thus avoid some membrane scaling problems. Other blends may result in compositions that are not supersaturated for certain problematic scaling minerals.

Table 2-1: Analysis of Sample #63367.

Analyte	mg/l
Ca	121
Mg	190
Na	236
K	2.2
Ba	0
Sr	0
NH4	0
Fe	0
Mn	1.81
HCO3	628
CO3	0.8
Cl	248
Br	2.1
SO4	541
F	0.6
NO3	213
PO4	0
SiO2	24
pH	7.2
TDS	2208

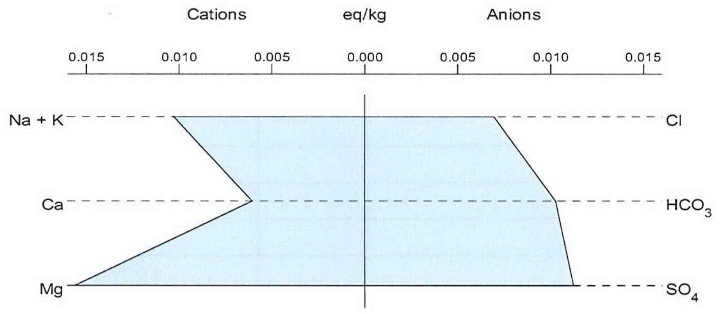

Figure 2-1: Stiff diagram of the composition of Sample #63367.

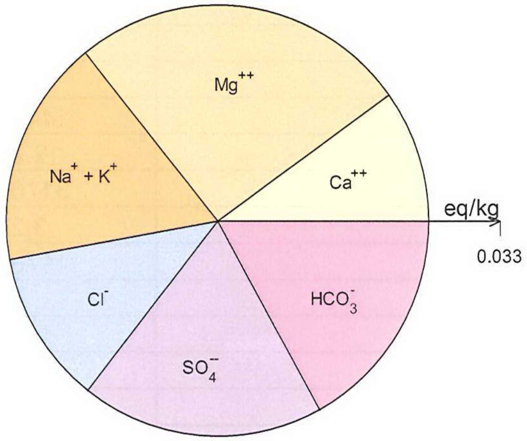

Figure 2-2: Pie chart of major ion composition of Sample #63367.

In light of this potential variation between actual feed waters and the sample used for this study, the conclusions contained within this report should be considered as findings specific only to feed waters that are similar in composition to Sample #63367. Should the desalination feedwater composition differ significantly from this sample, these conclusions may not apply and a reevaluation of selective precipitation potential will need to be done.

Importantly, the variability in water composition may provide a potential opportunity for blending to improve recovery and avoid some of the scaling problems identified in this report, as mentioned above.

Table 2-2: Composition of simulated RO brine calculated for the feed water corresponding to Sample #63367 analysis for 83% recovery using WinFlows 2004.

Analyte	mg/l
Ca	706
Mg	1112
Na	1361
K	12.5
Ba	0
Sr	0
NH_4	0
Fe	0
Mn	10.6
HCO_3	3624
CO_3	42
Cl	1442
Br	12.2
SO4	3170
F	3.2
NO3	1176
PO4	0
SiO2	140
pH	7.9
TDS	12811

The analysis in Table 2-1 was used as input to an RO simulation program (WinFlows2004) to calculate the brine composition. Thin-film brackish water membranes were used. Recovery was set at 83%. A sensitivity analysis showed that changing the number of stages, banks, and/or elements per housing, did not significantly affect the composition of the brine as long as system recovery rates were maintained at 83%. The resulting calculated brine composition at 83% is shown in Table 2-2.

Our initial calculations show that both the feed water and the brine at 83% recovery are supersaturated with respect to calcium carbonate. In addition, several types of scale are predicted to precipitate as the feed water is concentrated. In addition, laboratory procedures to concentrate the sample up to 83% by evaporation led to drop out of significant amounts of mineral scale. The total dissolved solids (TDS) concentration of the brine is nearly 13,000 mg/l. While this amount is not particularly high overall, it is sufficient to raise the concentrations of specific ions, notably bicarbonate (HCO_3^-), magnesium (Mg), and silica (SiO_2) to levels at which certain scale minerals become supersaturated. To verify the tendency for scale minerals to precipitate during recovery, we conducted laboratory procedures to concentrate the sample up to 83% by evaporation. These results are summarized in the next section.

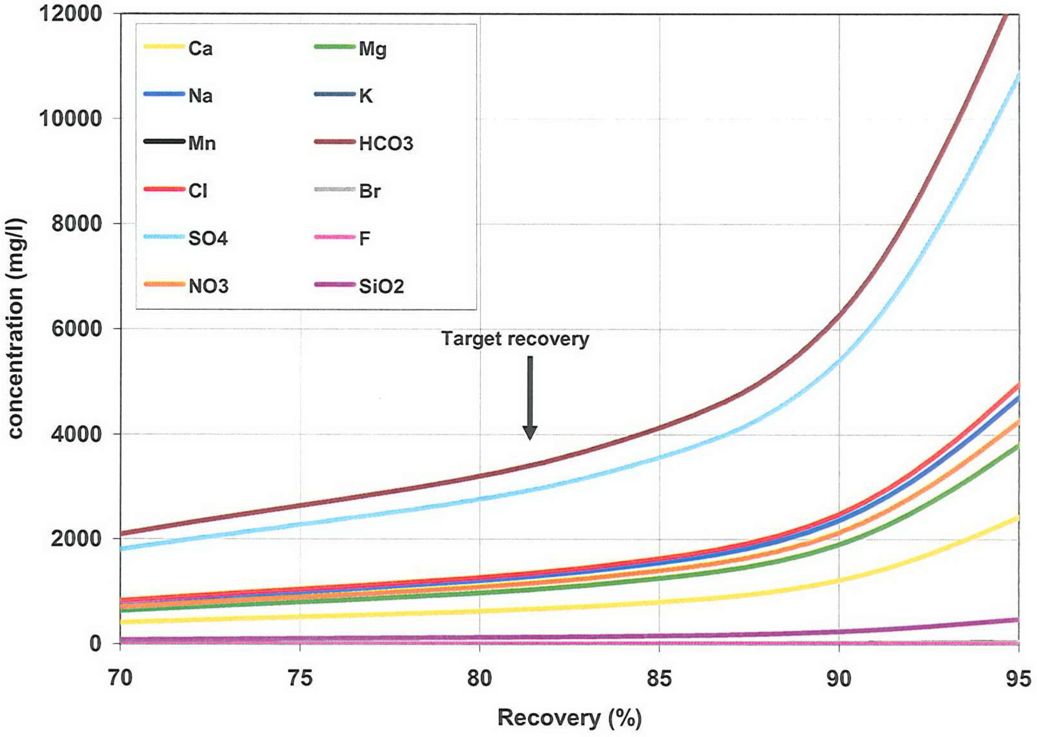

Figure 2-3: Changes in concentration (mg/l) of major ions over a range of recovery levels from 70 to 95%.

Given the high-scaling tendencies of this water, inconsistency of recovery rate selection in other aspects of the feasibility study, and potential need for testing of different recovery rates for field pilots, or that another recovery rate may eventually be selected as a more optimal recovery rate for the RO system, we decided to assess brine compositions over a range of recovery rates from 70 to about 95%. The changes in ion concentrations over this range are shown in Figure 2-3 for major ions, and Figure 2-4 for minor constituents.

Assuming that no scale precipitates formed as recovery proceeded, the changes in ion concentrations over this range are shown in Figure 2-3 for major ions, and Figure 2-4 for minor constituents. Figures 2-3 and 2-4 show a steady increase in concentrations of elements and maintenance of their relative ratios in solution during recovery because thin-film brackish water RO membranes, which were selected for the WinFlows software simulation, are generally non-selective. The high concentrations of bicarbonate, sulfate, magnesium, and in addition, sodium and chloride of the original sample water, and their relative ratios, are maintained as concentrations increase.

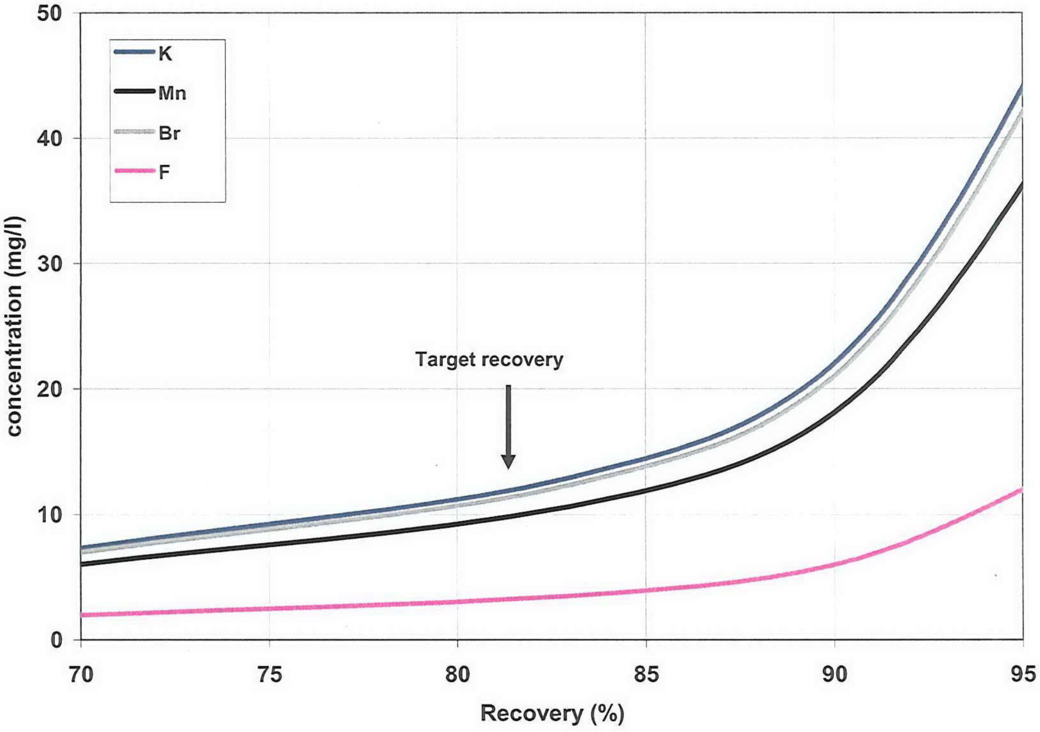

Figure 2-4: Changes in concentration (mg/l) of minor ions over a range of recovery levels from 70 to 95%.

3. Mineral Scaling and Recovery Potential

Preliminary Modeling

The extent of mineral saturation, which is a measure of the potential for scale precipitation, was calculated from the brine compositions. Expressed in terms of mineral saturation indices, the extent of saturation is used to determine the potential for significant scaling, to assess the potential for economic mineral recovery, and to assess the potential for hazardous concentrations of contaminants in residual solids. A number of computer codes and thermodynamic databases were used for these calculations.

Given the elevated salinity of the residual brines, we tested for differences in results given the approach used by different codes and databases to calculate ion activity coefficients for solutions. The computer code GWB (Bethke, 1996) was used with LLNL thermodynamic databases representing the use of the extended Debye-Huckel and the Pitzer activity coefficient models. The thermodynamic database associated with the Debye-Huckel model contained data for a larger number and variety of minerals than the Pitzer model. However, the Pitzer database contained the same classes of minerals, although the number of minerals within each class was not as extensive.

In previous studies, it has been determined that calculated saturation states can vary significantly if the salinity (ionic strength) effects are not properly accounted for. For this brine, it was unclear at what level of recovery such salinity effects would become significant. Over the range of concentrations considered here, and for the scaling minerals pertinent to this study, no significant differences were observed among the results obtained from the different codes. Although the Pitzer model is generally more applicable to highly saline brines, no significant differences in results using the two models were noted for the recovery percentages studied in this report. We found that scale predictions from the Pitzer database essentially matched scale predictions using the Debye-Huckel thermodynamic database.

Table 3-1: Minerals calculated from purely thermodynamic considerations that have potential to precipitate from a water with the composition of the Pajaro groundwater sample.

Amorphous silica	Gaylussite
Anhydrite	Gypsum
Aragonite	Halite
Barite	Hexahydrite
Bloedite	Hydromagnesite
Brucite	Kalicinite
Calcite	Kieserite
Chalcedony	Magnesite
Chrysotile	Mirabilite
Cristobalite	Monticellite
Diopside	Nesquehonite
Dolomite	Quartz
Enstatite	Rhodochrosite
Epsomite	Sylvite
Fluorite	Tephroite
Forsterite	Thenardite

Numerous mineral phases are predicted to precipitate from concentration of the Pajaro sample. Table 3-1 lists all the mineral phases that can potentially precipitate based on the ion concentrations of the Pajaro water. This table lists the mineral phases, based on thermodynamic calculation of saturation states that exceed or approach supersaturation. Supersaturation means the product of solution ion activities (similar to concentrations) exceeds or approaches the thermodynamic equilibrium value for the mineral phase. The suite of minerals that potentially can precipitate becomes an important consideration when selective mineral precipitation methods are engineered into operations to remove hazardous constituents or recover marketable byproducts.

However, in reality many of these phases do not precipitate under the conditions pertaining to the Pajaro groundwater or its concentrate brine. In addition to the condition of thermodynamic supersaturation, a mineral must be favored kinetically—that is, its rate of precipitation must be rapid enough to form in significant quantities.

Some phases are kinetically inhibited relative to other phases with identical compositions. For example, in the case of polymorphs, such as calcite and aragonite, which have the same chemical composition and stoichiometry of calcium and carbonate ions, but have different crystal structures, only one phase usually will precipitate. As is discussed below, aragonite is the phase that is favored by the conditions in the Pajaro sample and the conditions of the bench-scale test. Other phases might be favored if, for example, thermal desalination were used instead of reverse osmosis.

In the case of other minerals, the kinetics of precipitation are sluggish at low temperatures or because of other conditions, and these phases will be out-competed for their constituent ions by more rapidly precipitating phases. For example, under pertinent conditions, dolomite, consisting of magnesium, calcium and carbonate ions, precipitates much more slowly than calcite or aragonite, or magnesium carbonates such as hydromagnesite. Other phases, such as forsterite, require high temperatures and pressures to form.

The potential for some phases to precipitate either through engineered recovery operations or as scale can be eliminated based on temperature and pressure constraints or from knowledge of which minerals are common scale precipitates in RO operations. However, in some cases, assumptions may be incorrect, so laboratory tests to recover mineral precipitates from an actual water sample is the preferred approach for narrowing the list of mineral phases.

Laboratory Recovery Tests

The Pajaro H5-A well water sample was evaporated to an equivalent water recovery of 83% by gentle heating in a beaker to about 50°C over 6 hours on a hot plate. Two liters of solution were allowed to evaporate until about 340 ml remained. At this point, there was a significant amount (1-2 ml volume) of beige precipitate. The precipitate was only slightly effervescent in dilute HCl, indicating it was not primarily composed of a carbonate phase, which would bubble vigorously in acid. Our method for producing the 83% brine serves as a reasonable proxy for reverse osmosis treatment, which was not carried out as part of our study, both due to the additional expense, and the likelihood of irreversible fouling of the membranes. The extra expense of RO processing was not warranted at this stage, but would need to be carried out in the future.

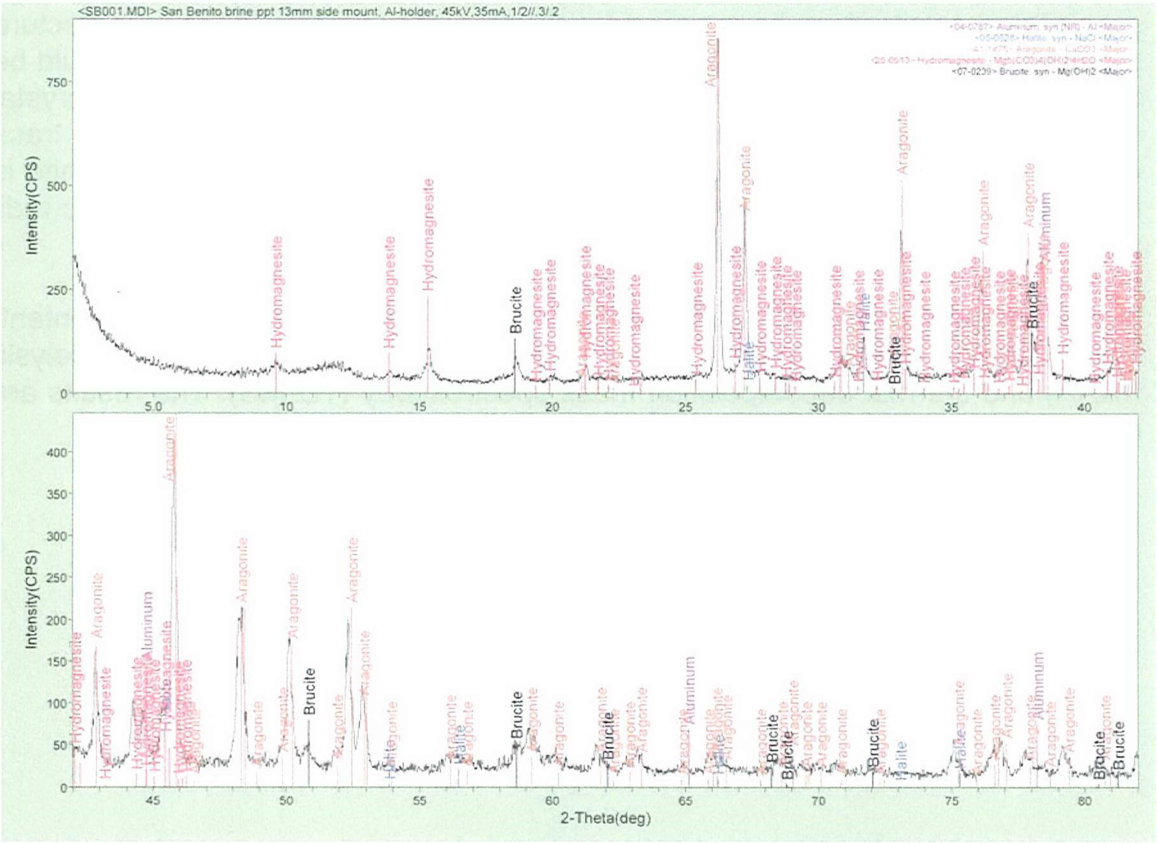

Figure 3-1: X-ray diffraction data showing mineral phases from Sample #66367 concentrate precipitate. Major scaling minerals include aragonite, brucite and hydromagnesite. Halite is also present.

This mixture was then decanted to produce a wet sludge, which was allowed to dry. The dried solid sample was analyzed by X-ray diffraction (XRD). The results are shown in Figure 3-1. The XRD scan shows the solids to be mixture of aragonite, hydromagnesite, brucite, halite, and a serpentine-like phase (7Å Mg-silicate), not labeled on the figure, but discussed below. Halite probably formed during the final drying of the wet paste from the residual solution and not during the initial evaporation process (see discussion below).

Scale mineral prediction, using as a basis the common groundwater scaling minerals, would have predicted calcite over aragonite as the calcium carbonate phase. However, studies show that in the presence of high concentrations of magnesium and sulfate, at low to moderate temperatures, aragonite is kinetically favored over calcite (Burton, 1993). With respect to treatments for scale removal or anti-scaling chemical applications, it is relatively unimportant whether calcite or aragonite is present. Both phases can be removed or prevented from precipitating by acid treatments. Their thermodynamic saturation states are offset by a constant factor such that calcite is always about one and one-half times more supersaturated than aragonite. However, from the standpoint of evaluation of commercial byproducts or waste residuals, it may be important. While precipitated calcite does have commercial value, for example in the manufacture of paper, it has little value when co-precipitated with other solids, which would be the case for the waters considered here. There are differences in crystal structure between calcite and aragonite, which means that different trace elements will coprecipitate within each phase. The cation space for aragonite is larger than it is in calcite. Consequently, trace elements with different ionic radii will coprecipitate into each mineral.

The solid precipitated in the laboratory was analyzed for its chemical content. Two analytical methods were used: Instrumental Neutron Activation Analysis (INAA) and thermal decomposition mass spectroscopy (TD-MS). The results are shown in Table 3-2.

Table 3-2: Elemental analysis of precipitate.

Analyte Symbol	Unit Symbol	ppm	Detection Limit	Analysis Method
Au	ppb	< 2	2	INAA
Ag	ppm	< 5	5	INAA
As	ppm	2.9	0.5	INAA
Ba	ppm	< 50	50	INAA
Br	ppm	191	0.5	INAA
Ca	%	13	1	INAA
Co	ppm	7	1	INAA
Cr	ppm	12	5	INAA
Cs	ppm	< 1	1	INAA
Fe	%	0.2	0.01	INAA
Hf	ppm	< 1	1	INAA
Hg	ppm	< 1	1	INAA
Ir	ppb	< 5	5	INAA
Mo	ppm	18	1	INAA
Na	%	1.75	0.01	INAA
Ni	ppm	< 20	20	INAA
Rb	ppm	< 15	15	INAA
Sb	ppm	1.1	0.1	INAA
Sc	ppm	0.2	0.1	INAA
Se	ppm	< 3	3	INAA
Sn	%	< 0.02	0.02	INAA
Sr	%	0.16	0.05	INAA
Ta	ppm	< 0.5	0.5	INAA
Th	ppm	< 0.2	0.2	INAA
U	ppm	26.9	0.5	INAA
W	ppm	< 1	1	INAA
Zn	ppm	< 50	50	INAA
La	ppm	0.9	0.5	INAA
Ce	ppm	< 3	3	INAA
Nd	ppm	< 5	5	INAA
Sm	ppm	< 0.1	0.1	INAA
Eu	ppm	< 0.2	0.2	INAA
Tb	ppm	< 0.5	0.5	INAA
Yb	ppm	< 0.2	0.2	INAA
Lu	ppm	< 0.05	0.05	INAA

Table 3-2 continued.

Analyte Symbol	Unit Symbol	ppm	Detection Limit	Analysis Method
Li	ppm	4.9	0.5	TD-MS
B	ppm	6	1	TD-MS
Na	%	1.71	0.001	TD-MS
Mg	%	> 10.0	0.01	TD-MS
Al	%	0.03	0.01	TD-MS
K	%	0.03	0.01	TD-MS
Ca	%	15.5	0.01	TD-MS
Cd	ppm	0.3	0.1	TD-MS
V	ppm	4	1	TD-MS
Cr	ppm	6.2	0.5	TD-MS
Mn	ppm	67	1	TD-MS
Fe	%	0.07	0.01	TD-MS
Hf	ppm	< 0.1	0.1	TD-MS
Ni	ppm	15.6	0.5	TD-MS
Er	ppm	< 0.1	0.1	TD-MS
Be	ppm	< 0.1	0.1	TD-MS
Ho	ppm	< 0.1	0.1	TD-MS
Ag	ppm	0.21	0.05	TD-MS
Cs	ppm	0.12	0.05	TD-MS
Co	ppm	0.7	0.1	TD-MS
Eu	ppm	< 0.05	0.05	TD-MS
Bi	ppm	0.04	0.02	TD-MS
Se	ppm	1.1	0.1	TD-MS
Zn	ppm	10.8	0.2	TD-MS
Ga	ppm	< 0.1	0.1	TD-MS
As	ppm	1.4	0.1	TD-MS
Rb	ppm	1.7	0.2	TD-MS
Y	ppm	0.6	0.1	TD-MS
Sr	ppm	> 1000	0.2	TD-MS
Zr	ppm	3	1	TD-MS

Table 3-2 continued.

Analyte Symbol	Unit Symbol	ppm	Detection Limit	Analysis Method
Nb	ppm	< 0.1	0.1	TD-MS
Mo	ppm	18	0.1	TD-MS
In	ppm	< 0.1	0.1	TD-MS
Sn	ppm	1	1	TD-MS
Sb	ppm	2.3	0.1	TD-MS
Te	ppm	7.6	0.1	TD-MS
Ba	ppm	65	1	TD-MS
La	ppm	0.5	0.1	TD-MS
Ce	ppm	0.3	0.1	TD-MS
Pr	ppm	0.1	0.1	TD-MS
Nd	ppm	0.1	0.1	TD-MS
Sm	ppm	< 0.1	0.1	TD-MS
Gd	ppm	< 0.1	0.1	TD-MS
Tb	ppm	< 0.1	0.1	TD-MS
Dy	ppm	< 0.1	0.1	TD-MS
Cu	ppm	8.7	0.2	TD-MS
Ge	ppm	< 0.1	0.1	TD-MS
Tm	ppm	< 0.1	0.1	TD-MS
Yb	ppm	< 0.1	0.1	TD-MS
Lu	ppm	< 0.1	0.1	TD-MS
Ta	ppm	< 0.1	0.1	TD-MS
W	ppm	1.7	0.1	TD-MS
Re	ppm	0.011	0.001	TD-MS
Tl	ppm	0.06	0.05	TD-MS
Pb	ppm	1.6	0.5	TD-MS
Th	ppm	< 0.1	0.1	TD-MS
U	ppm	24.7	0.1	TD-MS

These data show the precipitate is composed mainly of sodium, magnesium, and calcium, with lesser amounts of strontium, manganese, iron, barium, and uranium. The methods did not analyze for silicon, sulfur, or carbon so these data alone cannot be used to reconstruct the types of solids phases present. It was likely some combination of carbonates, sulfates, and silicates. The data do show that there appears to be only very small amounts of valuable components such as precious and rare earth elements, however, there are some elements that could be hazardous if they reach certain concentrations in desalination waste residuals.

We also note that in a full-scale membrane treatment system, some of the phases predicted to form may nucleate and grow so slowly that their constituents would pass through the membrane system before enough time had elapsed for them to precipitate. In that case, they would not give rise to a scaling problem.

Recovery vs. Scaling Tendencies

In this section, the results of modeling recovery vs. sacling tendencies is presented. In design of the desalination operation and in assessing the potential for solid residuals to be marketable or hazardous, it is important to understand how scaling depends on recovery. The saturation states of these minerals as a function of recovery are plotted in Figure 3-2. Because carbonate mineral saturations are sensitive to pH, saturation states also were calculated as a function of pH for aragonite and hydromagnesite (Figs. 3-3 and 3-4).

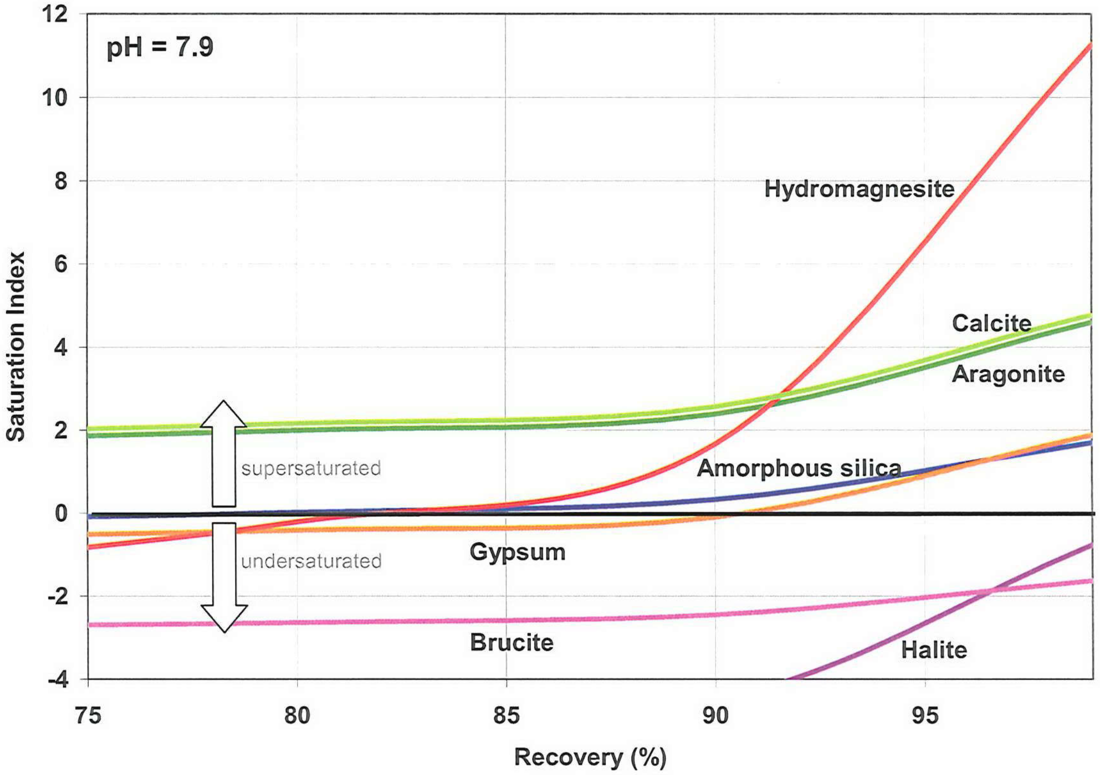

Figure 3-2: Saturation states (expressed as saturation indices, or log saturation) as a function of percent recovery. The pH was fixed at the 7.9 value obtained from the WinFlows simulation of RO, assuming no adjustment by additives.

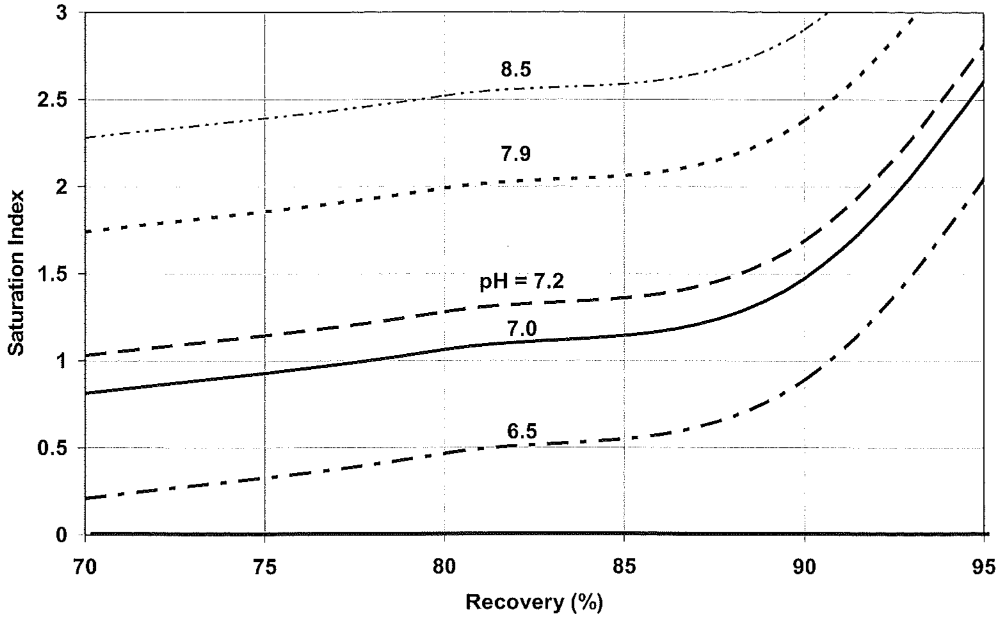

Figure 3-3 Aragonite saturation index as a function of percent recovery over a range of pH values from 6.5 to 8.5. For this fluid, aragonite is always supersaturated over the recovery percentage range and pH range examined. For calcite, the curves plot quite close to those for aragonite (See Fig. 3-3, above.).

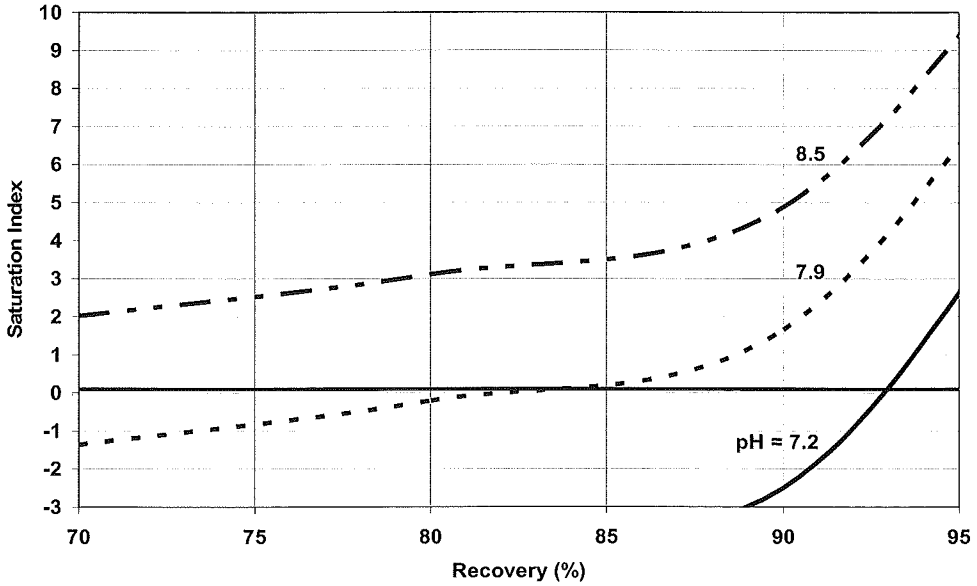

Figure 3-4: Hydromagnesite saturation index as a function of percent recovery over a range of pH values from 7.2 to 8.5. For this fluid, hydromagnesite becomes supersaturated at recovery percentages in excess of about 85% and pH values above 7.9.

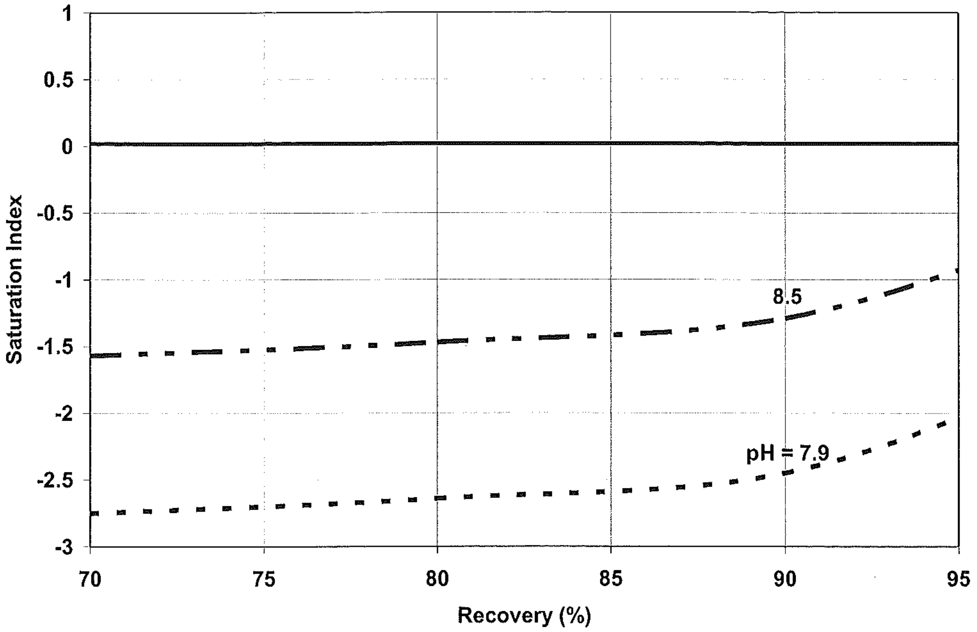

Figure 3-5: Brucite saturation index as a function of percent recovery at pH values of 7.9 and 8.5. For this fluid, brucite is predicted to be undersaturated at all recovery percentages until the last one percent is reached, even at pH values as high as 8.5.

At recovery rates above 83%, aragonite, hydromagnesite, and amorphous silica phases will precipitate from the brine. Gypsum also is predicted to precipitate at water recoveries above 90%. While precipitated gypsum could be recovered for commercial uses, for example in the manufacture of wallboard, it has little value when co-precipitated with other solids, which would be the case for the waters considered here. However, modeling does not predict formation of the brucite and halite phases found in the precipitate sample. These minerals remain undersaturated until the very last percent of the concentrate is removed.

Brucite, a magnesium hydroxide phase is also pH-sensitive. However, over the pH range used for this modeling, and considered reasonable for RO systems, brucite remained undersaturated (Fig. 3-5). The very last percent of brine had to be removed from the system, in other words, the brine has to evaporate to dryness to precipitate brucite according to the modeling. It is likely however that the laboratory precipitate, created by evaporation of the groundwater sample, also had pH values considerably higher than the 8.5 cutoff used for the modeling. Elevated pH values would promote brucite precipitation.

The precipitates observed in the laboratory experiment were used to validate forward modeling of the evaporation process. Figure 3-6 shows our prediction of the identity and mass of mineral scale that precipitates from 1 liter of #63367 groundwater upon evaporation to 99% recovery.

Two simulations were carried out. In the first, we assumed a closed system that does not exchange CO_2 with the atmosphere (Fig. 3-6). The pH is predicted to change from a starting value of 7.2 to a final value of 5.8, and the pressure of CO_2 is predicted to increase from 0.04 to 11.2 bars. These changes are caused by precipitation of the mineral phases shown in Fig. 3-6.

In the second, we allowed the system to equilibrate with atmospheric CO_2 (pressure of 0.0003 bars) (Fig. 3-7). In contrast to the previous simulation, in this simulation the pH is predicted to rise to 8.2. The mineral assemblage that is predicted to form assuming open conditions matches the minerals observed in the evaporation experiment, which is reasonable because the solution was free to exchange with the atmosphere during the experiment.

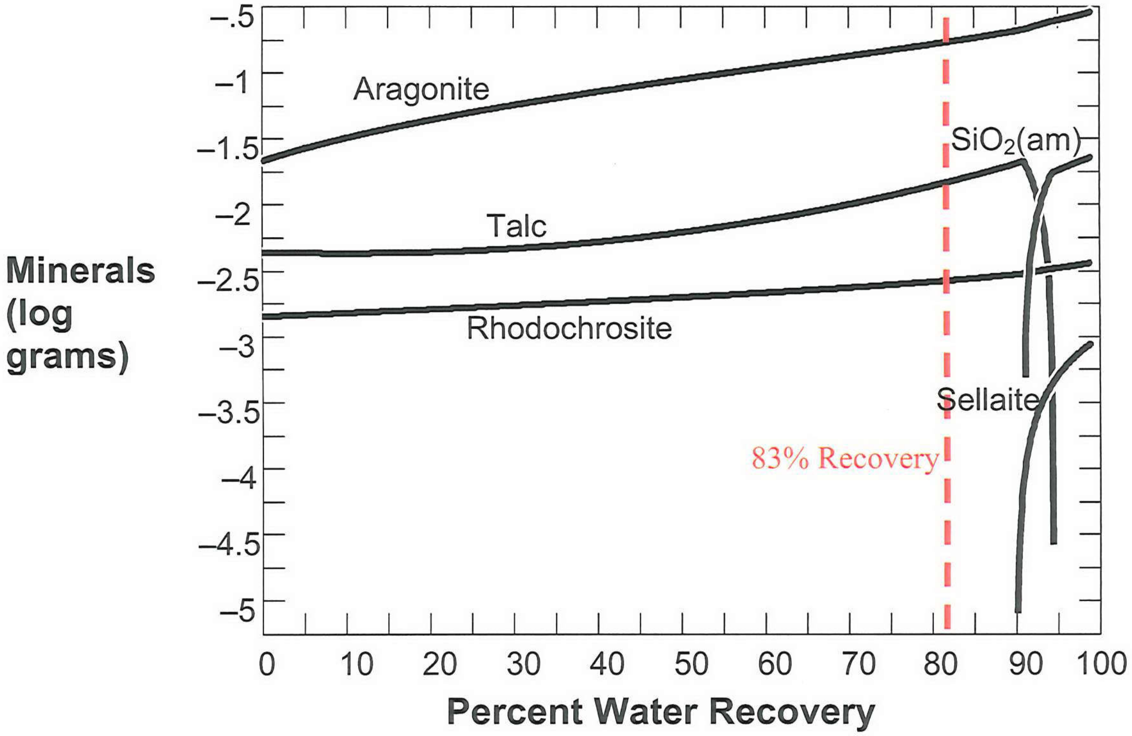

Figure 3-6: Predicted mineral precipitates predicted to form during concentration of Pajaro well water up to 99% recovery assuming a closed system that does not equilibrate with the atmosphere.

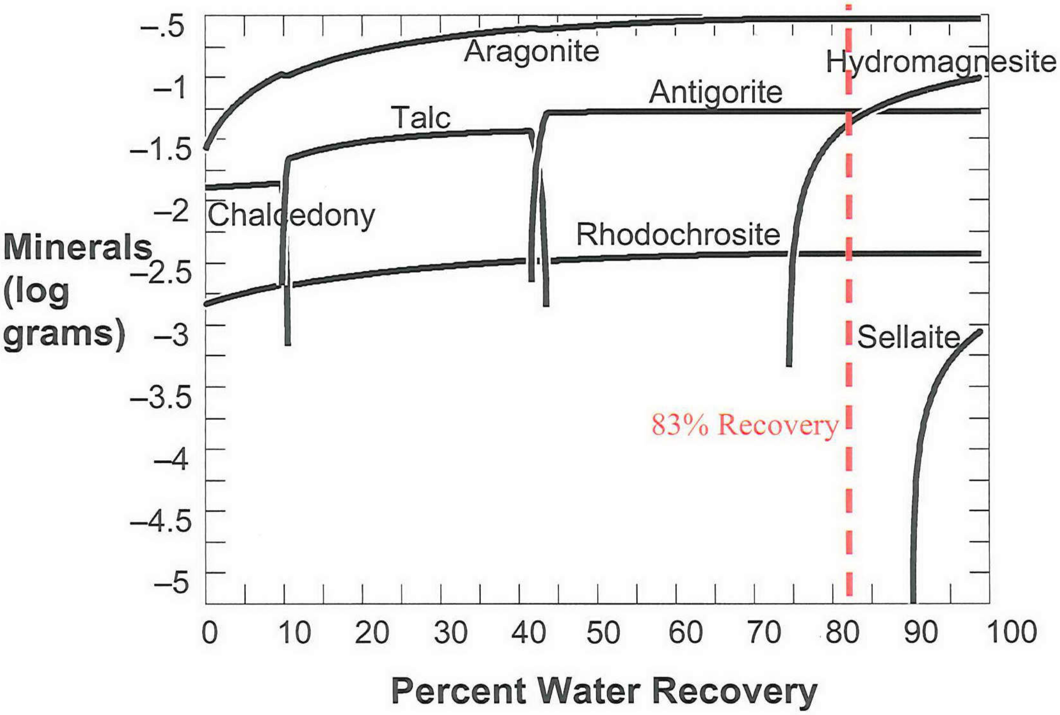

Figure 3-7: Predicted mineral precipitates predicted to form during concentration of Pajaro well water up to 99% recovery assuming an open system that equilibrates with atmospheric carbon dioxide.

In both simulations, the dominant solid precipitate is aragonite ($CaCO_3$) with lesser amounts of several magnesium-containing phases: talc ($Mg_3Si_4O_{10}(OH)_2$, antigorite ($Mg_3Si_2O_5(OH)_4$, and hydromagnesite ($Mg_5(CO_3)_4(OH)_2 \cdot 4H_2O$. Both hydromagnesite and a 7-Angstrom clay phase that is probably an amorphous form of antigorite were observed in the x-ray patterns (Fig 3-1 – broad peak at 12 degrees 2θ).

Minor amounts of rhodocrosite ($MnCO_3$) and sellaite (MgF_2) were also predicted to form. Given the large mass ratio of aragonite to rhodocrosite, it is likely that manganese (Mn) would co-precipitate in aragonite and not form a separate phase. The code we used to carry out the simulation did not provide for this type of solid solution behavior. A small amount of cryptocrystalline silica (chalcedony) and amorphous silica (SiO_2(am)) were also predicted to form. Both are difficult to detect using XRD.

Our prediction that fairly high CO_2 pressures (over 10 atmospheres in a closed system) would be generated during desalination due to mineral precipitation may be of concern for the design of the reverse osmosis system. The CO_2 is likely to be evolved in the RO permeate during processing and significantly reduce its pH and possibly effervesce.

Recoverable Byproducts

The mineral phases that predominantly precipitate from this brine, aragonite and hydromagnesite, have little to no commercial value. The minor amounts of halite and brucite also are not potential economic byproducts. The magnesium phases predicted or observed to form are not commonly marketed magnesium salts, and salts such as epsom salt ($MgSO_4 \cdot H_2O$) and brucite ($Mg(OH)_2$) are probably more cheaply produced by other methods (e.g., seawater extraction). Although potentially calcite and gypsum are predicted to form under some conditions and have value, they would have to be selectively precipitated to separate them from other solids in order to be marketable. This is not likely to be economically viable because of they have relatively low market value. While silica precipitates may have some commercial value, the amounts precipitated per unit volume of brine are too small for the separation to be economic.

Sequestering Contaminants

The element analyses performed on the groundwater sample and on the laboratory brine formed by evaporation do not show significant concentrations of contaminants of concern. However, the analysis of the precipitate does indicate that certain elements are concentrating in the precipitate (Table 3-2). Concentrated elements include some contaminants of concern, such as uranium, arsenic, and copper.

Future studies of brine disposal options, for example, undertaken at a pilot scale, should perform analyses for these and other contaminants of concern on brines and precipitates. Care should also be taken in handling and disposal of scale formed during the RO process. To avoid potentially costly disposal costs should waste byproducts exceed regulatory limits, future studies should determine in which mineral phases these contaminants occur. If sequential precipitation methods or chemical treatments can be used to isolate the contaminated phases, the volume of contaminated waste for disposal may be significantly reduced. It may also be possible to develop approaches to assure that reject brines stay below regulatory limits for these compounds for brine disposal options by inducing their preferential partitioning into solid mineral phases.

Blending of Well Waters

Another option for reducing mineral scaling issues and consequent issues with creation of contaminated scales or evaporative solids is to blend this groundwater with other waters within the basin that have compatible compositions. One challenge with this brine is that pH alteration for the purposes of controlling carbonate mineral scales may exacerbate the formation of silica phases.

Scaling can be prevented through optimization of blending different basin waters in various percentages. The optimal combinations can be determined through modeling the mineral precipitates and scaling that would occur over a range of blends. LLNL software has this capability, but we were unable to pursue this line of investigation due to limited information and data on the various water compositions within the basin.

4. Bench-scale Tests

Introduction

As part of the feasibility study, we have carried out a matrix of desalination tests using available commercial membranes as well as newly developed nanoporous electrodialysis membranes developed at LLNL. The goal of these tests was to provide preliminary data to evaluate methods and costs for:

- extracting additional water from the brackish source
- co-production of possible marketable by-products

Our assumption is that this might be done by adding an additional desalination step beyond reverse osmosis, by selective mixing of fluids from wells that results in mineral precipitation, through selective extraction of components from the well waters prior to desalination, or other treatment schemes discussed below.

We carried out tests of both raw Pajaro well water and well water from which 83% of the water had been recovered, simulating the reverse osmosis process. The suite of membranes included two sets of commercial membranes obtained from Ionics and Asahi, and nanoporous polycarbonate membranes obtained from GE-Osmonics that were modified for use as electrodialysis membranes at LLNL. The tests were carried out using a single pair of membranes in a re-circulating system of approximately 25 ml. The tests were not of sufficient size in terms of membrane surface area and flow to extract representative energy consumption data, but they do provide side-by-side data which is useful for comparing the different membranes and their selectivities. Also of concern is whether or not the small-scale tests provide compelling information on the likelihood of membrane scaling and fouling. As mentioned previously, a full-scale system with higher rates of throughput may or may not have the same scaling issues depending on whether the fluids pass through the system prior to the onset of mineral precipitation.

Membrane Materials

Two types of commercial electrodialysis membranes were tested. The Ionics materials were cut from sheets of AR 204 SXZL 386 anion membrane and Ionics CR 61 AZL 386 cation membrane. The membranes are ion exchange materials with cloth-reinforced construction. The cation membrane is made of a film of cross-linked sulfonated copolymers of vinyl compounds, which are cast in sheet form on a synthetic reinforcing fabric. The sulfonic acid groups in these membranes provide the fixed negative charges. The anion membranes are made of cross-linked vinyl copolymers containing quaternary ammonium groups which are the source of the positive charges (Meller, 1984).

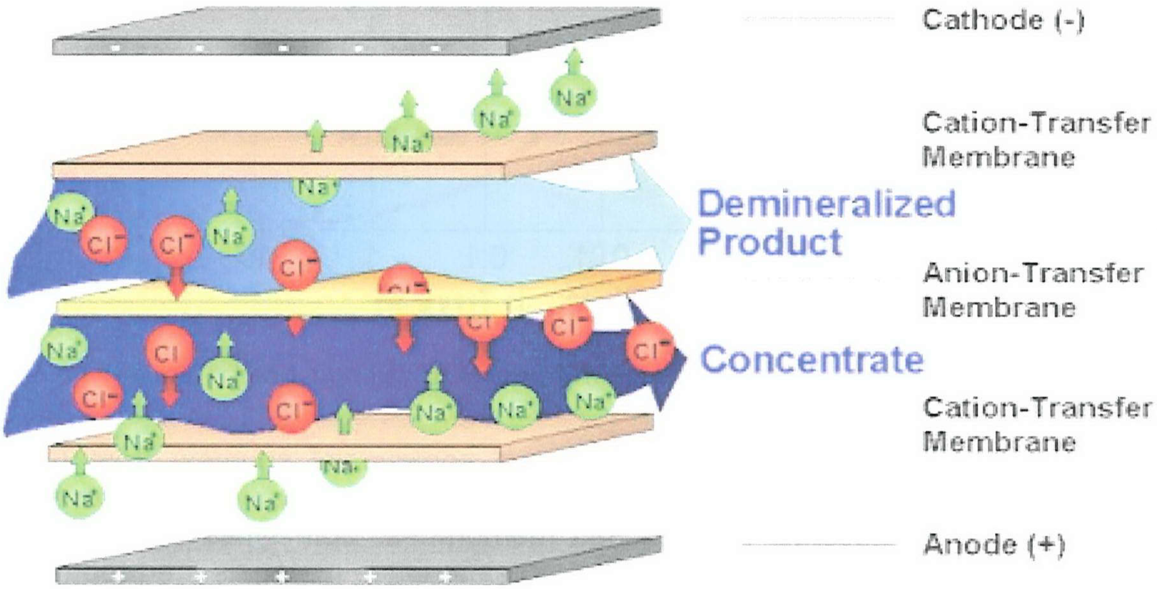

Figure 4-1: Typical electrodialysis configuration where a static electric field is applied across a stack of alternating cation and anion permeable membranes. As fluid is pumped through, alternate compartments become more or less saline due to ion migration through the membranes.

The Asahi membranes were the Selemion monovalent selective type anion membrane and CMV sulfonated cation membrane ASV both based on a polystyrene-divinylbenzene polymer. “Monovalent selective” refers to the selective transport of monovalent vs. divalent anions across the membrane. The behavior is caused by the application of a negatively charged surface layer onto the membrane of sufficient charge density that it repels divalent ions, but is not so strong that monovalent ions are not able to pass through the surface layer and into the membrane. The electrostatic field of the end plates drives this ion motion. Test data below show a strong preferential transport of nitrate over sulfate through these membranes, which may be useful for removing or controlling sulfate scale, as discussed below.

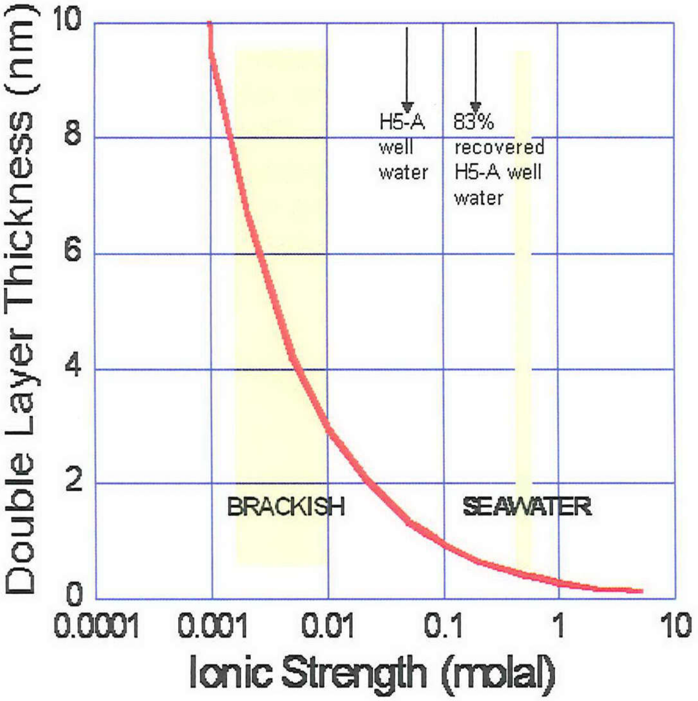

Figure 4-2: Double layer thickness as a function of ionic strength (for 1:1 electrolyte).

The nanoporous membranes were from two commercial sources; from GE-Osmonics and from Incubateur Activalis (IT4IP), a small company in Belgium that specializes in high quality, track etched membranes. Both types of materials were ion track etched polycarbonate. The pores in these materials are produced by exposing the thin polymer sheets to high-energy ions which penetrate through the sheet. The damaged ion tracks are then etched, usually in alkali, which removes the polymer material in the volume of the track. The pore sizes range from a minimum of about 10 nm (the intrinsic pore size of damaged polymer) to greater than 500 nm. The IT4IP membranes were found to have the most monodisperse and smallest pore sizes of any commercial track etched membranes that we have characterized.

Electrodialysis membranes need to be selectively permeable either to anions or cations, but not both. This allows the DC electric field to remove ions of both types from alternate compartments between membranes (see Fig. 4-1). Nanoporous membranes can function as electrodialysis membranes (will be selectively permeable to either cations or anions) provided the pores are small enough that they exist in a "double layer overlapped" condition. When a polymer such as polycarbonate is placed in water, it develops a surface charge that is balanced by an accumulation of ions near the surface that are opposite in charge. Because polycarbonate has a negative surface charge at near-neutral pH, there is an accumulation of positive ions near the membrane. This ion accumulation is called a double layer. The same condition exists inside pores of the polycarbonate in that the pore walls are coated with a layer of ions that balance the surface charge. The thickness of this layer is a function of salinity; the more saline the fluid, the thinner the layer, as shown in Figure 4-2.

For typical brackish waters the thickness of the double layer is around 4 to 8 nanometers. When the pore radius is approximately the same or smaller than the double layer thickness, the pore is filled mainly with ions opposite in charge to the surface charge. If the membrane is subjected to an electric field gradient normal to the membrane surface, the pores will transport only the type of ion that occupies the pore volume. In this case, since positive ions occupy the pore, only positive ions (cations) will be transported across the membrane.

An anion membrane can be made by applying a positive surface charge to a similar material such that the pores are occupied predominantly by anions.

We tested 10nm Osmonics membranes that were functionalized three different ways:

1. Titanium coupling agent – Membrane dipped in a 1% solution of LICA-38 J (Kenrich Petrochemical) for a few seconds and then reacted under UV light for 10 minutes to attach the positively charged surface layer
2. DICH-TEA functionalized – Membrane immersed in solution of di-isocyantohexane and triethyamine and rinsed in heptane
3. HxDA/heptane – Membrane immersed for one hour in heptane containing 2% hexanediamine and rinsed in pure heptane.

The membrane materials had a nominal pore diameter of 10 nm and pore density of 10^9 pores/cm^2. SEM imaging of the Osmonics material indicated the pores ranged in size up to 20-30 nm. The Belgian samples had much smaller and more monodisperse pores but they were not consistently present across the over the entire area of material. Most of the pores in the Belgian samples had diameters of 8-12 nm.

It is possible that the functionalization process could block the pores, or that it could appreciably reduce the size of the pores. Based on our test results, that does not appear to have happened. Functionalized anion membranes were always found to have nearly the same permeability to ion transport as non-functionalized cation membranes.

Because the relatively high salinities of the test solutions relative to double layer thickness (Fig. 4-2), it was not expected that 10 nm pores would exist in an overlapped condition and therefore might not function as cation and anion selective membranes. For this reason we also included a nanofiltration membrane in our test matrix that has nominally 1-1.5 nm pores, and should therefore be in an overlapped condition. The NF membrane has an intrinsic negative charge and therefore was expected to be cation selective.

Membrane Tests

Test methods

We carried out desalination tests of both straight Pajaro well water and a brine derived from well water by evaporation (described previously) using five combinations of membrane pairs (Table 4-1 and 4-2.). The brine tests were carried out in order to provide data that would help to determine both whether additional water might be recovered from the reverse osmosis concentrate and also whether mineral recovery from the brine might be possible. Electrodialysis membrane tests are difficult to interpret when they are carried out using only a single membrane because of electrode reactions, which affect the pH of the solution. On one side, the solution pH increases, while on the other, it decreases. The pH difference increases as the test progresses. It is difficult to deconvolute the effect of the pH gradient from the membrane performance for ion transport.

Table 4-1: Membrane pairs used in electrodialysis tests

Cation	Anion
Ionics	Ionics
Asahi	Asahi
Nanoporous	Nanoporous (functionalized)
Asahi	Nanoporous
Reverse Osmosis (nanofiltration)	Asahi

Table 4-2: Nanoporous membranes tested.

NP OS	Nanoporous polycarbonate Osmonics 10nm (cation) not functionalized
BOS10C	Osmonics 10 nm track etched polycarbonate (anion) functionalized using Ti-coupling agent LICA-38J

KL34b	Hexanediamine coupled Osmonics 10nm, 10 minute soak
KL34a	Hexanediamine coupled Osmonics 10nm, 30 minute soak

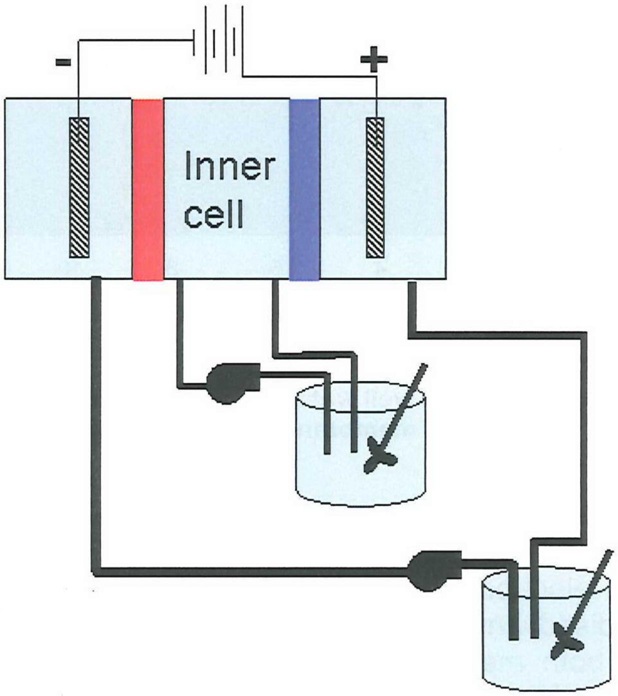

Figure 4-3: Schematic of test apparatus. Inner cell is separated from outer cells in contact with platinum electrodes by cation (red, left) and anion (blue, right) membranes. Fluids from electrode compartment are mixed to neutralize any pH changes caused by electrolysis. In this configuration, the inner cell fluid becomes less saline with time.

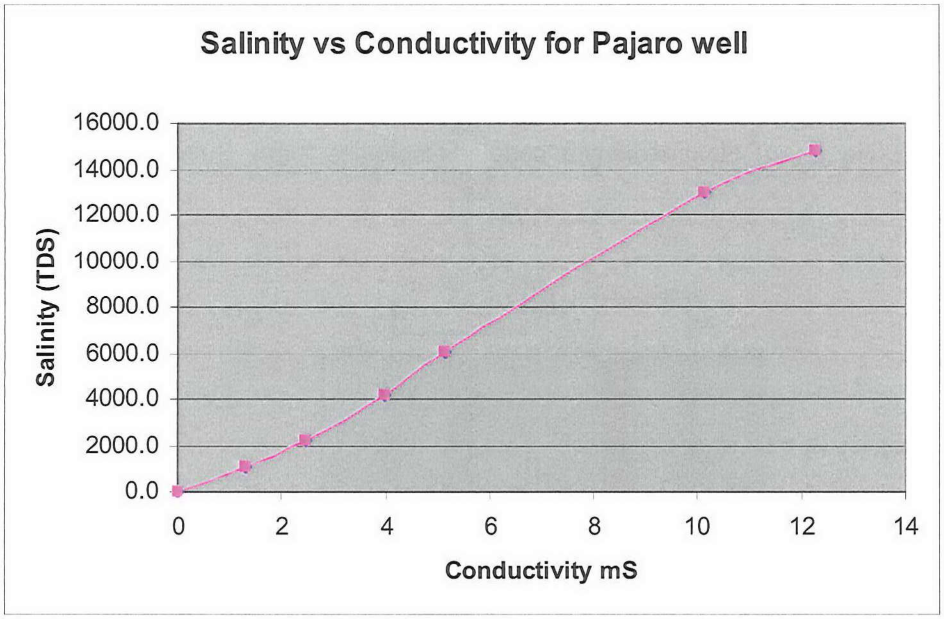

Figure 4-4: Conductivity of Pajaro well water as a function of salinity. Data were used to calculate membrane energy efficiency.

To avoid this, we tested a membrane pair that separates an inner fluid chamber from the outer electrode compartments (see Fig. 4-3). The advantage is that the fluids in the two electrode compartments are mixed to neutralize any pH changes. The disadvantage is that the test result is a function of the characteristics of both membranes, which cannot be deconvoluted. Only the combined efficiency of the membrane pair can be determined.

In our tests, 25 ml of fluid is added to the inner compartment, and 80 ml added to the electrode compartment. Fluids are continuously circulated through both chambers with peristaltic pumps at a rate of about 100 ml/minute. Previous tests have shown that the rate of movement of ions through the membranes is not affected by flow rates in this range, indicating the chambers are well mixed and that macroscopic boundary layer affects are not limiting transport. Both fluid lines enter and exit a Pyrex beaker where pH and conductivity measurements of the fluid are carried out. Conductivity data is used to determine the rate of salt movement across the membranes.

The electrical potential across the cell is generated using two pieces of platinum mesh to which platinum wires have been soldered and connected to a DC power supply. The energy used to carry out ion transport is calculated from the integrated current times voltage. The amount of salt transported is determined from the change in conductivity. Data for the change in conductivity with salinity of concentrated Pajaro well water is shown in Fig. 4-4.

Table 4-3: Chemical analyses of feed solutions for electrodialysis tests. Well waters A and B are duplicates.

Major elements (mg/L)	**Well water sample A**	**Well water sample B**	**Brine**
Na+	240	238	1548
Li+	n.d.	n.d.	0.4
Mg++	185	186	750
K+	12	12	24
Ca++	80	<70	198
Sr++	1.5	0.5	2.3
F-	9.5	11.1	--
SO4--	639	635	--
Cl-	232	220	--
Br-	5.1	3.5	5.1
NO3-	133	142	--
Minor elements (ug/L)	**Well water sample A**	**Well water sample B**	**Brine**
Al	<200	<200	540
Ti	50	40	36
Ni	30	40	180
Zn	<50	<50	1233
As	<3	4	4.5
Se	<20	<20	45
Rb	1.1	1.0	5.1
Y	0.7	0.7	0.5
Mo	10	10	18
Sb	1	1	0.9
Cs	0.2	0.3	0.3
Ba	30	<10	63
Pb	9	19	7
U	14	7	0.6
These elements were analyzed for and were below detection limits for ICP-MS: Be, Sc, V, Cr, Mn, Fe, Co, Cu, Ga, Ge, Zr, Nb, Ru, Pd, Ag, Cd, In, Sn, Te, I, La, Ce, Pr,Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, Re, Os, Pt, Au, Hg, Tl, Bi, Th			

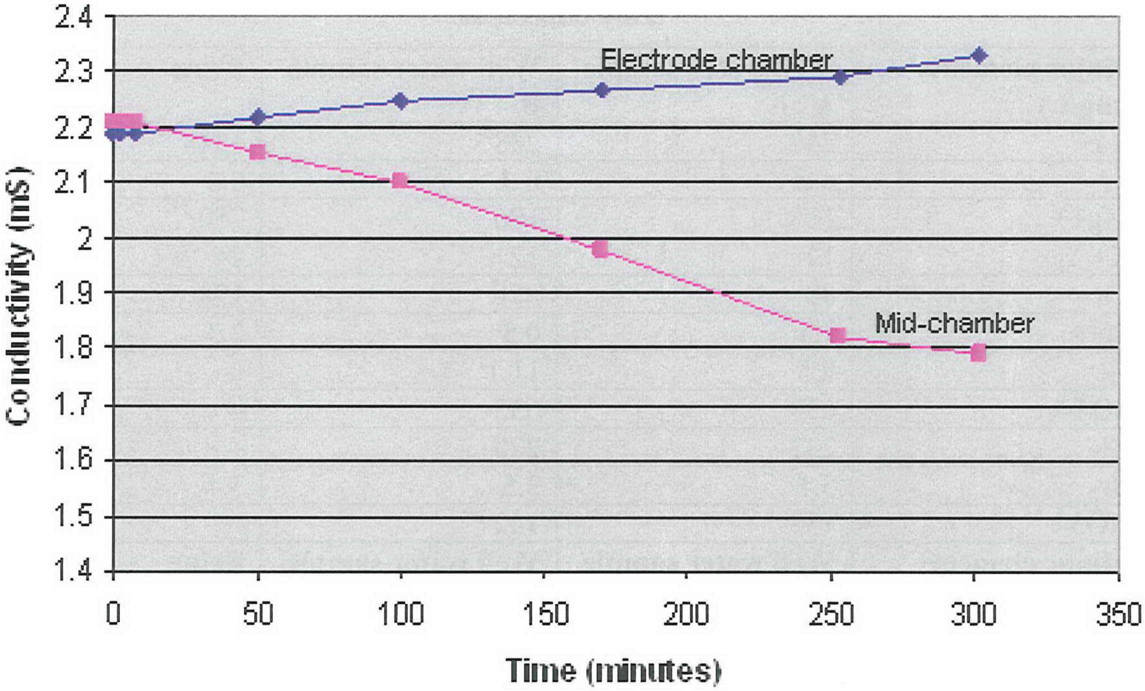

Figure 4-5: Conductivity vs. time data for test of Asahi membranes in Pajaro H5-A well water.

The test fluid obtained from well H5-A was kept in a dark enclosure to avoid biological activity. An 83% recovered brine was produced by evaporative heating for six hours of a container of raw water at about 50°C until the volume of the fluid was 17% of the starting volume. This served as a simple proxy for reverse osmosis processing. The measured compositions as analyzed for the bench-scale tests of the two fluids (starting well water and concentrated brine) are given in Table 4-3. These analyses generally compare well with the analytical data shown in Tables 1-1 and 1-2 above, but there are differences. The differences between the compositions shown here in Table 4-3 and those shown previously in Tables 2-1 and 2-2 may be due to real variability in waters produced from well H5-A over time, as well as differing amounts of mineral precipitation and fluid degassing during storage.

All tests were carried out at room temperature. To begin each test, the membranes were placed in the cell (after wetting the nanoporous membranes with alcohol) and the cells filled with water. Fluid was then pumped through the system without an applied potential until both the conductivity and pH readings stabilized. This generally took about 2-5 minutes. The power to the platinum electrodes was then turned on (typically to 5 volts) and conductivity, pH, voltage, and current reading taken continuously. Typical test data are shown in Figure 4-5.

The polarity of the test was generally applied such that the inner cell became less concentrated with time. This was to avoid the precipitation of mineral phases in the inner cell fluid so that conductivity changes in the inner cell could be assumed to represent the amount of salt moved through the membranes. If mineral precipitation takes place, the conductivity change will decrease by an unknown amount. Solid precipitates were often observed in the electrode cells, due to the increase in salt content in those fluids as well as pH changes due to electrochemical reactions on the electrodes. Some changes in the slope of conductivity vs. time for the electrode fluids are likely due to this effect.

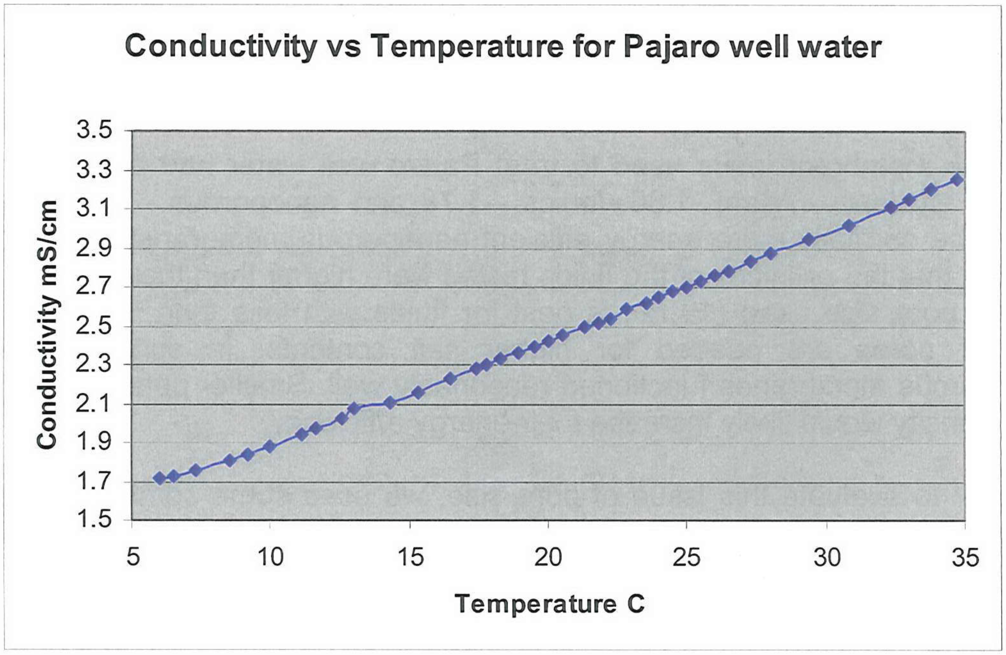

Figure 4-6: Measured conductivity vs. temperature for Pajaro well water.

The raw test data were corrected for temperature changes using measured data for the change in conductivity with temperature of Pajaro well water (Fig. 4-6). Because the conductivity changes fairly rapidly with temperature due to the change in viscosity of water, it was necessary to correct even for a few degrees of temperature change over the several hour long time period of a test. The electodialysis process itself tends to heat the solutions a few degrees due to electrical resistance.

Test results

Our goal for these lab-scale tests is to compare membrane performance in terms of energy use and species selectivity. The data is meant to be useful for evaluating novel uses of electrodialysis and reverse osmosis to extract a greater amount of water from the brackish well sources, develop methods for minimizing brine disposal costs, and if possible develop methods to co-produce marketable by-products. Given budget and time constraints, most of this effort was carried out using preliminary computer models and not laboratory tests.

Selected data is shown in the tables within the text. The complete set of test results and analytical data is given in the Appendix.

Energy use

Table 4-4 shows the energy use for the various membrane combinations tested. This data should be used only as a guide to relative performance. The values are fairly high relative to full-scale desalination technologies. Energy use should improve with scale-up.

All three membrane pairs used to treat Pajaro well water had about the same energy efficiency (Asahi -1.86, Ionics - 1.78 and nanoporous - 2.09 in W-hr/g salt). The normally more energy efficient nanoporous membranes suffered from the fact that the salinities of the fluids tested were higher than the optimum range for the pore size used (10 nm is best for fluids with less than 500 ppm TDS). Smaller pores are needed for higher salt contents. In spite of this, the nanoporous membranes functioned reasonably well. Smaller pores and a higher pore density would likely increase their energy efficiency.

In order to evaluate this issue of pore size, we used some commercial reverse osmosis membrane material as a cation membrane. These materials have a smaller pore size and should be in a fully overlapped condition for the well water salinities. However, our test results did not show favorable energy use (2.43 W-hr/g salt).

Table 4-4: Relative energy use for membrane pairs.

Cation	Anion	Solution	Volts	W-hr/g salt
Asahi	Asahi	San Benito well water - raw	7	2.56
Asahi	Asahi	San Benito well water - raw	5	1.86
Asahi	Asahi	San Benito well water - raw	5	3.36
Asahi	Asahi	San Benito - 83% recovered	5	(0.97)
Ionics	Ionics	San Benito well water - raw	5	1.78
Ionics	Ionics	San Benito - 83% recovered	5	4.20
NP Os 10nm	KL34b	San Benito well water - raw	5	2.09
Asahi	KL34b	San Benito - 83% recovered	5	(11.71)
OsmonicsNF (RO)	Asahi	San Benito well water - raw	5	3.05
OsmonicsNF (RO)	Asahi	San Benito - 83% recovered	5	2.43

* The data given in parenthesis is suspect due to extreme pH changes probably due to solids precipitation.

Membrane Selectivity

To get some information on membrane selectivity, we obtained a sample of the Asahi monovalent selective anion membrane for use in these tests. As mentioned above, the membrane selects against divalent anions by having a fixed negative charge placed on the membrane surface which acts to repel negatively charged ions. The charge sufficient to repel doubly-charged species such as sulfate, but still allows monovalent species such as chloride to pass through the charged surface layer and into the membrane.

Our test results for membrane selectivity are shown in Tables 4-5 (for anions) and 4-6 (for cations). The tables provide a calculated value for the ratio of concentrations of two ions (e.g. sulfate/nitrate) in the mid-chamber of the test system at the end of the test, divided by the same ratio for the starting fluid. If there has been no selective transport of ions across the membrane, the ratio will be close to one, as most of the data show. If the ratio is greater than one, it indicates that the ion in the numerator is enriched in the diluate fluid relative to the ion in the denominator. For example, for sample PAC-2, the sulfate to nitrate ratio is 10.2, indicating that 10 times less sulfate passed through the anion membrane than nitrate. This is expected as this is the monovalent-selective Asahi membrane used to separate divalent sulfate from monovalent anions. In carrying our electrodialysis with these membranes, the diluate will contain most of the sulfate present in the solution, and the brine will contain most of the nitrate and chloride. Note that these membranes also pass nitrate preferentially to chloride (value of 3.08), probably reflecting the greater ionic mobility of nitrate vs. chloride because nitrate is only weakly hydrated relative to chloride.

Note that the nanoporous membrane tests (samples PNBL and PNOT) show no anion preference. Also, when a nanoporous anion membrane is swapped in for the Asahi membrane, the monovalent selectivity disappears as expected (sample PCNH).

The cation selectivity data shows no strong selectivity for any cation ratios examined. There is some enhanced transport of divalent cations over monovalent cations evidenced by values larger than one for Na^+/Ca^{++} and Na^+/Sr^{++}. This is expected because the divalent ions feel twice the coulombic force of the monovalent ions. A problematic aspect of some of these data is that there should be a corresponding decrease in the same ratio for the concentrate fluid. The lack of corresponding decrease is probably due in most cases to solids precipitation in the brine cell, which affects the ratios in a way that cannot be determined without information on the solids phase compositions.

Table 4-5: Normalized anion ratios in test fluids.

Cation Membrane	Anion Membrane	Solution Sampled	Sample ID	Starting Solution	Cl-/ NO3-	SO4--/ NO3-	SO4--/ Cl-	SO4--/ F-
Asahi	KL34b	diluate	PCNH-1	brine	1.01	1.00	0.99	
Asahi	KL34b	conc.	PCNH-2	brine	1.05	1.02	0.97	0.77
Asahi	KL34b	conc.	PCNH-3	brine	1.02	0.95	0.94	
Asahi	Asahi	diluate	PAC-2 DILUANT		3.08	10.20	3.31	
Asahi	Asahi	diluate	*PAC-*	brine	1.27	0.99	0.78	0.39
Asahi	Asahi	conc.	PAC-3A CONC	brine	1.01	0.82	0.81	
Asahi	Asahi	conc.	PAC-	brine	1.02	0.98	0.96	0.90
Asahi	Asahi	conc.	PAC-3B CONC	brine	0.98	0.80	0.81	0.70
Asahi	Asahi	conc.	PAC-3B	brine	1.06	1.03	0.98	
Asahi	KL34b	diluate	PNH-1	well water	1.03	1.19	1.16	0.74
Asahi	KL34b	conc.	PNH-2	well water	1.04	1.04	1.00	1.34
Asahi	KL34b	conc.	PNH-3	well water	1.02	1.02	1.00	1.36
Asahi	KL34b	conc.	PNH-3	well water	1.03	1.03	1.00	
Belgian10nm	KL34a	diluate	PNBL-1	well water	1.15	1.19	1.03	1.00
Belgian10nm	KL34a	conc.	PNBL-2	well water	0.98	1.01	1.03	1.21
Belgian10nm	KL34a	conc.	PNBL-	well water	0.97	0.99	1.03	1.22
NP OS	BOS10C	diluate	PNOTi-	well water	1.12	1.05	0.94	1.01
NP OS	BOS10C	conc.	PNOTi-2	well water	0.98	1.01	1.04	1.23
NP OS	BOS10C	conc.	PNOTi-3	well water	0.99	1.05	1.05	
Ionics	Ionics	diluate	PI-2 DILUANT	well water	2.77	0.33	0.12	*0.06*
Ionics	Ionics	conc.	PI-3A	well water	1.24	1.05	0.85	1.40
Ionics	Ionics	conc.	PI-3B	well water	1.28	1.08	0.85	1.42
Asahi	Asahi	diluate	PA-2	well water	1.56	3.54	2.27	1.29
Asahi	Asahi	conc.	PA-3A	well water	0.92	0.83	0.91	1.23
Asahi	Asahi	conc.	PA-3B	well water	0.94	0.85	0.90	1.23

Table 4-6: Normalized cation ratios in test fluids.

Cation Membrane	Anion Membrane	Solution Sampled	Sample ID	Starting Solution	Na+/ Mg++	Na+/ Ca++	Na+/ Sr++	Na+/ K+	Na+/ Rb+	Na+/ Cs+
Asahi	KL34b	diluate	PCNH-1	brine	1.21	1.19	1.15	0.94	1.22	0.76
Asahi	KL34b	conc.	PCNH-2	brine	1.02	0.70	0.64	0.86	0.96	0.66
Asahi	Asahi	diluate	PAC-2 DILUANT		1.74	1.95	1.63	0.81	1.23	1.33
Asahi	Asahi	conc.	PAC-	brine						
Asahi	Asahi	conc.	PAC-3B CONC	brine	1.00	0.85	0.84	0.94	0.92	0.77
Asahi	KL34b	diluate	PNH-1	well water	2.31		3.79	0.76	0.96	0.60
Asahi	KL34b	conc.	PNH-2	well water	1.01		0.98	0.70	0.69	0.31
Belgian10nm	KL34a	diluate	PNBL-1	well water	1.08		1.71	0.68	0.68	0.55
Belgian10nm	KL34a	conc.	PNBL-2	well water	0.98	2.25	0.74	0.91	1.03	0.24
NP OS	BOS10C	diluate	PNOTi-	well water	0.99		1.40	0.70	0.75	0.45
NP OS	BOS10C	conc.	PNOTi-2	well water	0.99	2.35	0.97	0.95	0.98	0.50
Ionics	Ionics	diluate	PI-2 DILUANT	well water	5.33		2.37	0.58	1.32	
Ionics	Ionics	conc.	PI-3A	well water	1.03	1.92	0.65	1.03	0.84	1.44
Asahi	Asahi	diluate	PA-2	well water	1.16		1.53	0.77	0.97	0.61
Asahi	Asahi	conc.	PA-3A	well water	0.93	1.81	0.64	0.88	0.77	0.61

5. Summary

Modeling and bench-scale results indicate that electrodialysis energy efficiency and membrane selectivity may be of less economic significance than issues having to do with membrane scale and fouling control for this particular water composition. There is little likelihood that commercial mineral byproducts can be economically extracted from brine produced from this water. Results indicate there are some operational issues that should be addressed during facilities and process design. In addition, the potential for blending groundwaters from other parts of the watershed should be explored conceptually, possibly followed by pilot tests, to determine whether scaling issues can be addressed and water recovery rates can be improved.

Our nanoporous membranes have a comparable energy efficiency to commercial membranes, so that they provide no clear advantage for this water composition. It is likely that a nanoporous membrane with smaller pore size, such that it would exhibit double layer overlap for the salinity of the test fluid, would have an improved energy efficiency. The pores would need to be less than 4 nm in diameter. The Asahi monovalent selective membranes could be used to separate sulfate, and would provide a method for innovative scale control processes that mix the sulfate-enriched ED diluate fluid with other well solutions that are high in hardness. In general, these lab tests were made difficult by mineral precipitation, membrane fouling, and in one case a clearly visible coating of biofilm growing on the pH electrode and thermocouple in the beaker containing the electrode solution.

More work is needed to examine the range of fluid compositions available in the Pajaro River Watershed and to develop strategies for mixing the fluids to enhance or reduce mineral precipitation. This approach may have the potential to increase water recovery and reduce the amount of waste brine of the overall process.

From an operational standpoint, our modeling results suggest that:

- CO_2 is likely to be evolved in the RO permeate during processing and significantly reduce its pH and possibly effervesce;
- pH alteration for the purposes of controlling carbonate mineral scales may exacerbate the formation of silica phases;
- blending with other groundwaters may improve prospects for marketable mineral extraction, and/or reduce mineral scaling issues, but this concept requires further study;
- solid residuals appear to concentrate uranium, arsenic and copper—it will be important in further studies to carefully evaluate whether actual RO residuals contain these or other hazardous trace elements at levels exceeding regulatory limits.

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Appendix 1: Table of anion analytical data.

Cation Membrane	Anion Membrane	ED output	Sample Name:	F-	Cl-	NO3-	SO4--	Cl/ NO3	SO4/ NO3	SO4/ Cl	SO4/ F
well water											
Asahi	Asahi	well input	PA-1 20X DIL	9.49	232.4	133.3	639	1.7	4.8	2.7	67.3
Ionics	Ionics	well input	PI-1 20X DIL	11.09	219.5	141.7	635	1.5	4.5	2.9	57.3
conc. well water											
Ionics	Ionics	brine input	PIC-1 200X DIL	*89.92*	*994.2*	*639.8*	*2939*	1.6	4.6	3.0	32.7
Asahi	Asahi	brine input	PAC-1 500X DIL	217.24	1484.4	877.6	4319	1.7	4.9	2.9	19.9
				0.41	0.7	0.7	1				
Asahi	KL34b	diluate	PCNH-1 500X DIL		1326.6	808.4	3850	1.6	4.8	2.9	
Asahi	KL34b	conc.	PCNH-2 500X DIL	219.65	1560.8	914.7	4436	1.7	4.9	2.8	20.2
Asahi	KL34b	conc.	PCNH-3 500X DIL		1582.0	959.1	4348	1.6	4.5	2.7	
Asahi	Asahi	diluate	PAC-2 DILUANT 500X DIL		413.6	82.7	4015	5.0	48.6	9.7	
Asahi	Asahi	diluate	PAC-2 500X DIL	256.15	1147.7	556.8	2614	2.1	4.7	2.3	10.2
Asahi	Asahi	conc.	PAC-3A CONC 500X DIL		1814.8	1109.3	4318	1.6	3.9	2.4	
Asahi	Asahi	conc.	PAC-3A 500X DIL	216.93	1825.0	1107.6	5155	1.6	4.7	2.8	23.8
Asahi	Asahi	conc.	PAC-3B CONC 500X DIL	217.96	1689.7	1057.2	4016	1.6	3.8	2.4	18.4
Asahi	Asahi	conc.	PAC-3B 500X DIL		1808.3	1053.1	5177	1.7	4.9	2.9	

Cation Membrane	Anion Membrane	ED output	Sample Name:	F-	Cl-	NO3-	SO4--	Cl/ NO3	SO4/ NO3	SO4/ Cl	SO4/ F
Asahi	KL34b	diluate	PNH-1 20X DIL	8.67	121.3	71.7	398	1.7	5.5	3.3	45.8
Asahi	KL34b	conc.	PNH-2 20X DIL	8.77	258.6	151.1	732	1.7	4.8	2.8	83.5
Asahi	KL34b	conc.	PNH-3 20X DIL	8.67	259.1	155.0	733	1.7	4.7	2.8	84.5
Asahi	KL34b	conc.	PNH-3 20X DIL	0.00	259.4	153.4	731	1.7	4.8	2.8	
Belgian10nm	KL34a	diluate	PNBL-1 20X DIL	8.75	187.3	98.8	545	1.9	5.5	2.9	62.3
Belgian10nm	KL34a	conc.	PNBL-2 20X DIL	8.72	226.3	140.7	658	1.6	4.7	2.9	75.4
Belgian10nm	KL34a	conc.	PNBL-3 20X DIL	8.74	228.3	143.5	662	1.6	4.6	2.9	75.7
NP OS	BOS10C	diluate	PNOTi-1 20X DIL	8.81	210.1	113.8	556	1.8	4.9	2.6	63.1
NP OS	BOS10C	conc.	PNOTi-2 20X DIL	8.66	227.6	141.5	666	1.6	4.7	2.9	76.9
NP OS	BOS10C	conc.	PNOTi-3 20X DIL	0.00	223.8	136.9	666	1.6	4.9	3.0	
Ionics	Ionics	diluate	PI-2 DILUANT 20X DIL	9.08	108.0	23.7	36	4.6	1.5	0.3	4.0
Ionics	Ionics	conc.	PI-3A 20X DIL	8.99	326.6	160.6	782	2.0	4.9	2.4	87.0
Ionics	Ionics	conc.	PI-3B 20X DIL	8.78	325.3	154.5	776	2.1	5.0	2.4	88.4
Asahi	Asahi	diluate	PA-2 20X DIL	8.81	110.2	42.9	705	2.6	16.4	6.4	80.1
Asahi	Asahi	conc.	PA-3A 20X DIL	8.77	262.3	173.3	671	1.5	3.9	2.6	76.5
Asahi	Asahi	conc.	PA-3B 20X DIL	8.72	263.7	170.2	669	1.5	3.9	2.5	76.7

Appendix 2. Table of cation analytical data.

Analyte Symbol	Na	Li	Mg	Si	K	Ca	Sr	Br	Al	Be	Sc
Unit Symbol	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	ug/L	ug/L
Detection Limit	5	1	1	200	30	700	0.04	3	2	0.1	1
Analysis Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
PI-1	240	<100	185	<20	12	80	1.5	5.1	<200	<10	<100
PI-2	151	<100	22	<20	13	<70	0.2	1.1	<200	<10	<100
PI-3A	288	<100	216	<20	14	100	1.4	4.9	<200	<10	<100
PA-1	238	<100	186	<20	12	<70	0.5	3.5	400	<10	<100
PA-2	244	<100	163	<20	16	<70	0.5	1.6	1900	<10	<100
PA-3A	245	<100	204	<20	14	90	1.2	4.1	<200	<10	<100
PNBL-1	218	<100	157	<20	16	<70	0.4	3.2	300	<10	<100
PNBL-2	236	<100	187	<20	13	70	1.0	3.6	1000	<10	<100
PNOTi-1	223	<100	174	<20	16	<70	0.5	2.8	500	<10	<100
PNOTi-2	247	<100	193	<20	13	70	0.8	3.3	400	<10	<100
PNH-1	241	<100	81	<20	16	<70	0.2	2.5	<200	<10	<100
PNH-2	250	<100	192	<20	18	<70	0.8	5.8	400	<10	<100
PCNH-1	1440	0.4	570	<18	23	153	1.8	12.6	<180	<9	<90
PCNH-2	1557	0.4	728	<18	27	279	3.5	5.6	<180	<9	<90
PIC-1	1548	0.4	750	<18	24	198	2.3	14.7	270	<9	<90
PAC-1	1665	0.4	788	<18	24	207	2.3	15.6	540	<9	<90
PAC-2	1251	0.4	344	<18	23	81	1.1	8.5	<180	<9	<90
PAC-3B	1818	0.5	872	<18	29	270	3.1	3.5	900	<9	<90
PI-1 W/ACETIC	233	0.1	189	29	2	69	1.5	1.9	<20	<1	15
PAC-1 W/ACETIC	1508	0.4	738	100	14	170	2.2	11.4	<120	<6	76
PAC-3B W/ACETIC	1835	0.4	883	120	19	249	3.3	2.0	<120	<6	76
PAC-2 W/ACETIC	1294	0.3	352	119	14770	77	1.2	5.3	<120	<6	69

Analyte	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se
Unit	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Detection Limit	0.1	0.1	0.5	0.1	10	0.005	0.3	0.2	0.5	0.01	0.01	0.03	0.2
Analysis Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
PI-1	50	<100	<50	<10	<1000	<0.5	30	<200	<50	<1	<1	<3	<20
PI-2	40	<100	<50	<10	<1000	<0.5	<30	<200	<50	<1	<1	<3	<20
PI-3A	40	<100	<50	<10	<1000	1.3	30	<200	60	<1	<1	4	<20
PA-1	40	<100	<50	<10	<1000	<0.5	40	<200	<50	<1	<1	4	<20
PA-2	50	<100	<50	<10	<1000	<0.5	50	20	90	<1	<1	4	<20
PA-3A	50	<100	<50	<10	<1000	<0.5	50	<200	50	<1	<1	4	<20
PNBL-1	40	<100	<50	<10	<1000	<0.5	50	<200	60	<1	<1	3	<20
PNBL-2	30	<100	<50	<10	<1000	<0.5	60	310	210	<1	<1	4	<20
PNOTi-1	40	<100	<50	<10	<1000	<0.5	50	<200	60	<1	<1	<3	<20
PNOTi-2	40	<100	<50	<10	<1000	<0.5	30	<200	120	<1	<1	<3	<20
PNH-1	40	<100	<50	<10	<1000	<0.5	60	<200	130	<1	<1	<3	<20
PNH-2	40	<100	<50	<10	<1000	1	60	<200	70	<1	<1	<3	<20
PCNH-1	36	<90	<45	<9	<900	<0.45	135	<200	72	<0.9	<0.9	3.6	27
PCNH-2	45	<90	<45	<9	<900	<0.45	189	27	108	<0.9	<0.9	5.4	45
PIC-1	36	<90	<45	<9	<900	<0.45	198	<180	90	<0.9	<0.9	3.6	36
PAC-1	36	<90	<45	<9	<900	<0.45	180	<180	1233	<0.9	<0.9	4.5	45
PAC-2	36	<90	<45	<9	<900	<0.45	243	<180	162	<0.9	<0.9	4.5	45
PAC-3B	27	<90	<45	<9	<900	1.4	252	27	153	<0.9	<0.9	4.5	36
PI-1 (w/acetic)	4	2	17	<1	<100	0.2	66	<2	<2	<0.1	0.2	2.6	11
PAC-1 (w/acetic)	13	<6	88	<6	<600	<0.3	476	<12	<30	<0.6	<0.6	8.5	85
PAC-3B (w/acetic)	22	<6	96	<6	<600	1.5	858	23	47	<0.6	<0.6		
PAC-2 (w/acetic)	16	<6	86	<6	<600	0.3	255	<12	35	<0.6	<0.6		

Analyte	Rb	Y	Zr	Nb	Mo	Ru	Pd	Ag	Cd	In	Sn	Sb	Te

Unit	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Detection Limit	0.005	0.003	0.01	0.005	0.1	0.01	0.01	0.2	0.01	0.001	0.1	0.01	0.1
Analysis Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
PI-1	1.1	0.7	2	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PI-2	0.5	0.7	<1	<0.5	<10	<1	<1	<20	<1	<0.1	<10	1	<10
PI-3A	1.5	0.7	7	<0.5	20	<1	<1	<20	<1	<0.1	<10	1	<10
PA-1	1	0.7	<1	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PA-2	1.1	0.7	2	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PA-3A	1.4	0.5	<1	<0.5	380	<1	<1	<20	2	<0.1	<10	1	<10
PNBL-1	1.4	0.7	<1	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PNBL-2	1	0.6	2	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PNOTi-1	1.3	0.7	3	<0.5	10	<1	<1	<20	1	<0.1	<10	1	<10
PNOTi-2	1.1	0.6	<1	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PNH-1	1.1	0.6	<1	<0.5	<10	<1	<1	<20	<1	<0.1	<10	1	<10
PNH-2	1.6	0.7	<1	<0.5	10	<1	<1	<20	<1	<0.1	<10	1	<10
PCNH-1	3.7	0.63	<0.9	<0.45	18	<0.9	<0.9	<0.18	2.7	<0.09	<9	0.9	<9
PCNH-2	5.1	0.63	<0.9	<0.45	18	<0.9	<0.9	<0.18	3.6	<0.09	<9	0.9	<9
PIC-1	5.0	0.54	<0.9	<0.45	18	<0.9	<0.9	<0.18	3.6	<0.09	<9	1.8	<9
PAC-1	5.1	0.54	<0.9	<0.45	18	<0.9	<0.9	<0.18	4.5	<0.09	<9	0.9	<9
PAC-2	3.2	0.63	<0.9	<0.45	9	<0.9	<0.9	<0.18	2.7	<0.09	<9	0.9	<9
PAC-3B	6.2	0.63	<0.9	<0.45	18	<0.9	<0.9	<0.18	3.6	0.09	<9	1.8	<9
PI-1 (w/acetic)	0.9	<0.03	<0.1	<0.05	11	<0.1	<0.1	<2	<0.1	<0.01	<1	0.1	1
PAC-1 (w/acetic)	5.3	<0.18	<0.6	<0.3	19	<0.6	<0.6	<12	3.4	<0.06	<6	0.8	<6
PAC-3B (w/acetic)	6.5	<0.18	<0.6	<0.3	17	<0.6	<0.6	<12	3.2	0.1	<6	0.9	<6
PAC-2 (w/acetic)	3.5	<0.18	<0.6	<0.3	10	<0.6	<0.6	<12	1.9	<0.06	<6	0.7	<6
Analyte	I	Cs	Ba	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho
Unit	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L

Detection Limit	1	0.001	0.1	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Analysis Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
PI-1	<100	0.2	30	0.3	0.3	<0.1	<0.1	0.2	0.1	0.1	<0.1	<0.1	0.1
PI-2	<100	<0.1	<10	0.3	0.2	<0.1	<0.1	0.2	<0.1	0.2	<0.1	<0.1	0.1
PI-3A	<100	0.2	20	0.4	0.3	<0.1	0.6	<0.1	<0.1	0.1	<0.1	<0.1	0.1
PA-1	<100	0.3	<10	0.7	0.8	0.1	0.6	0.2	<0.1	0.1	<0.1	<0.1	0.1
PA-2	<100	0.4	<10	0.3	0.3	<0.1	0.2	0.1	<0.1	0.2	<0.1	<0.1	0.1
PA-3A	<100	0.4	20	0.3	0.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
PNBL-1	<100	0.4	<10	0.3	0.3	<0.1	<0.1	0.1	<0.1	0.1	<0.1	<0.1	0.1
PNBL-2	<100	1	20	0.4	0.4	<0.1	0.3	0.3	<0.1	0.2	<0.1	<0.1	0.1
PNOTi-1	<100	0.5	<10	0.3	0.3	<0.1	0.1	0.2	<0.1	<0.1	<0.1	<0.1	0.1
PNOTi-2	<100	0.5	10	0.3	0.3	<0.1	0.2	<0.1	<0.1	0.2	<0.1	<0.1	0.1
PNH-1	<100	0.4	<10	0.3	0.3	<0.1	0.3	0.1	<0.1	<0.1	<0.1	<0.1	0.1
PNH-2	<100	0.8	10	0.4	0.3	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
PCNH-1	<90	0.4	45	0.3	0.2	<0.09	0.27	<0.09	<0.09	0.09	<0.09	<0.09	<0.09
PCNH-2	<90	0.5	99	1.0	2.8	<0.09	0.54	0.18	<0.09	0.18	<0.09	<0.09	<0.09
PIC-1	<90	0.4	63	0.3	0.3	<0.09	0.09	0.09	<0.09	0.18	<0.09	<0.09	<0.09
PAC-1	<90	0.3	63	0.3	0.3	<0.09	<0.09	0.18	<0.09	<0.09	<0.09	<0.09	<0.09
PAC-2	<90	0.2	27	0.3	0.2	<0.09	0.36	0.09	<0.09	0.09	<0.09	0.09	<0.09
PAC-3B	<90	0.5	99	3.4	1.4	<0.09	0.18	0.18	<0.09	0.27	<0.09	0.09	<0.09
PI-1 (w/acetic)	133	0.2	27	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
PAC-1 (w/acetic)	435	0.7	73	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
PAC-3B (w/acetic)	290	0.7	104	3.5	1.2	<0.06	0.2	0.1	<0.06	0.3	<0.06	<0.06	<0.06
PAC-2 (w/acetic)	221	0.2	30	0.1	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Analyte	Er	Tm	Yb	Lu	Hf	Ta	W	Re	Os	Pt	Au	Hg	Tl
Unit	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
Detection	0.001	0.001	0.001	0.001	0.001	0.001	0.02	0.001	0.002	0.3	0.002	0.2	0.001

Limit													
Analysis Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS	ICP-MS
PI-1	<0.1	<0.1	0.1	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PI-2	<0.1	<0.1	0.1	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PI-3A	<0.1	<0.1	<0.01	<0.1	0.1	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PA-1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PA-2	<0.1	<0.1	0.2	<0.1	0.1	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PA-3A	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PNBL-1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PNBL-2	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	0.1	<0.2	<30	<0.2	<20	<0.1
PNOTi-1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PNOTi-2	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PNH-1	<0.1	<0.1	<0.01	<0.1	<0.01	<0.1	<2	<0.1	<0.2	<30	<0.2	<20	<0.1
PNH-2	<0.1	<0.1	0.1	<0.1	<0.01	<0.1	<2	0.1	<0.2	<30	<0.2	<20	<0.1
PCNH-1	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.18	0.5	<0.18	<27	<0.18	<18	<0.09
PCNH-2	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.18	0.6	<0.18	<27	<0.18	<18	<0.09
PIC-1	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.18	0.7	<0.18	<27	<0.18	<18	<0.09
PAC-1	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.18	0.6	<0.18	<27	<0.18	<18	<0.09
PAC-2	<0.09	<0.09	<0.09	<0.09	<0.09	<0.09	<0.18	0.2	<0.18	<27	<0.18	<18	<0.09
PAC-3B	<0.09	<0.09	<0.09	<0.09	0.09	<0.09	<0.18	0.8	<0.18	<27	<0.18	<18	<0.09
PI-1 (w/acetic)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.2	0.1	<0.02	<3	<0.02	<2	<0.01
PAC-1 (w/acetic)	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	4.0	0.8	<0.12	<18	<0.18	<12	<0.06
PAC-3B (w/acetic)	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	3.3	0.9	<0.12	<18	0.3	<12	<0.06
PAC-2 (w/acetic)	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	2.1	0.2	<0.12	<18	<0.18	<12	<0.06

Analyte	Pb	Bi	Th	U
Unit	ug/L	ug/L	ug/L	ug/L
Detection Limit	0.01	0.3	0.001	0.001

Analysis Method	ICP-MS	ICP-MS	ICP-MS	ICP-MS
PI-1	9	<30	<0.1	13.9
PI-2	9	<30	<0.1	0.4
PI-3A	10	<30	<0.1	9.6
PA-1	19	<30	<0.1	6.7
PA-2	10	<30	<0.1	10.0
PA-3A	9	<30	<0.1	10.7
PNBL-1	11	<30	<0.1	5.8
PNBL-2	16	<30	<0.1	12.0
PNOTi-1	10	<30	<0.1	5.9
PNOTi-2	10	<30	<0.1	10.3
PNH-1	12	<30	<0.1	6.9
PNH-2	11	<30	<0.1	10.2
PCNH-1	8	<27	<0.9	5.0
PCNH-2	14	<27	<0.9	4.3
PIC-1	8	<27	<0.9	0.7
PAC-1	7	<27	<0.9	0.6
PAC-2	8	<27	<0.9	1.1
PAC-3B	39	<27	<0.9	2.2
PI-1 (w/acetic)	<0.1	<3	<0.01	14.3
PAC-1 (w/acetic)	<0.6	<18	<0.06	0.6
PAC-3B (w/acetic)	23	<18	<0.06	2.0
PAC-2 (w/acetic)	1	<18	<0.06	1.1